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目　次

移植法對水稻雜交第二代後裔農藝性狀變異及相關之

影響 ……………………………………………………………張萬來…… 1

水稻宿根栽培方法之研究

(第二報) 品種間再生力及產量之變異 …………謝全份、高樹、江忠……14

甘藷品種「冲繩100號」引種經過及試驗成績………………簡金寬……22

流動方程式及其在土壤水分移動之應用 ……………………李蘭帝……31

化學元素對作物病原菌之影響

第二報 Hg, Ni, Sn, Pb, Fe, Al 等元素對稻熱病及

稻紋枯病菌發育之影響 ……………………………徐水泉、杜自彊……38

稻熱病菌對水銀離子耐性之研究 …………………………………簡錦忠……44

酸桔葉片殊形潰瘍病斑之利用 ……………………………………楊騰金……51

西瓜蔓割病病原菌之研究 ………………胡開仁、宋細福、游健治……57

幾種主要蔬菜害蟲藥劑防治田間試驗…泰登、梁同庭、林勝吉……65

文献介紹……………………………………………………………………69

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INFLUENCE OF PLANTING METHODS ON THE VARIABILITY AND CORRELATIONS OF AGRONOMIC CHARACTERS IN THE F_2 POPULATIONS OF A *JAPONICA* RICE CROSS

by

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INTRODUCTION

The pedigree method of handling segregating progenies of rice hybrids has been the standard breeding procedure for breeders in Taiwan. In recent years, however, rice breeders are becoming increasingly aware of the drawbacks associated with the pedigree system, even though most of the leading varieties since 1920 have been developed under this method. It is now known that many agronomic characters of economic importance are quantitively inherited and are readily influenced by environmental conditions. Therefore, in the early segregating generations, especially in the F_2, selection for these traits is not effective. If, however, F_2 populations are maintained in larger sizes, the efficiency of selection could be raised as better opportunities are given for the desired recombinants to be included in the populations. Unfortunately, rice breeders in Taiwan have only limited land area available for their segregating progenies and it is impossible to keep F_2's in large populations.

The bunch planting method provides an inexpensive means of carrying F_2 populations in adequate sizes than is generally possible in a conventional method of spaced planting. Should maximum genetic variance of important agronomic characters be obtainable in bunch-planted F_2 populations, selection under this condition would be more effective. The purpose of this investigation was to evaluate the genetic and environmental variability and correlations of some agronomic characters under the condition of bunch planting with the hope that information obtained may be useful to rice breeders.

REVIEW OF THE LITERATURE

The technique of planting hydrid seedlings in bunches was developed in 1935 in Hawaii for sugarcane breeding (Yang, 1957). It enables the breeders to carry populations in larger numbers. Selection under this condition has been reported to

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be effective. At the same time, the cost of land and labor can also be reduced. Juang (1962) conducted an experiment to study the effect of bunch planting method on the selection of promising and vigorous sugarcane plants and concluded that this method may prove to be advantageous in Taiwan.

By planting seedlings of segregating F_2 population in bunches, the plants are subjected to intense competition. The assumtion is often made that high yielding plants survive better in a competitive population. Elliot (1958) cited a number of instances to show that in seed crops natural selection generally favored the high yielding genotypes.

It has been shown mathematically that the expected variance of any non-segregating population is largely environmental variance, thus the total variance of a segregating population would be composed of genetic variance and environmental variance. Apparently, the resulting F_2 variance contained two parts, the genotypic fraction due to genic action, including dominance and epistasis, and another fraction due to environment. Bartley and Weber (1952) interpreted Lush's definition of heritability in two ways. In the broad sense, heritability refers to the ratio of heritable variance to total variance. In the narrow sense, heritability is defined as the ratio of additive genetic variance to total variance.

Correlation between two characters has been generally calculated in three forms, i. e. genotypic correlation which has genetic relationship, environmental correlation with no genetic relation, and phenotypic correlation which combine both genotypic and environmental effects together. Dewey and Lu (1959) partitioned correlation coefficients into components of direct and indirect effects.

Recently, it has become recognized that the degree of heritability of a given character varies with growing conditions. Akemine and Kumagai (1958) reported that heritabilities and correlations of some agronomic characters in segregating generations of a rice cross changed with different time of planting. Heritability values in late planting were found to be higher than those of standard planting season. Gotoh and Osanai (1959) suggested that if a high estimate of a given character is obtainable under a particular set of conditions, the efficiency of selection for this character could be enhanced in this environment. Rumbaugh (1963) observed that the relationship between a component of yield and yield per plant altered as alfalfa plants were spaced closer together. Kariya and Yamamoto (1963) concluded that the best method for breeding rice varieties adapted to high planting density is to conduct selection under high planting density.

Matsuo (1956) reviewed the literature regarding the heritability of rice and found that heritabilities for plant type, plant height, number of grains per panicle and length of panicles are generally high while those of panicle weight and number of panicles are relatively low, especially in the early segregating generations. Bollich (1957) reported that heritability estimates for spikelet length and heading date in F_2 generation of a rice cross were 0.86 and 0.63, respectively. Grain yield had a low heritability value. The correlation coefficient of heading date and yield was

estimated at -0.61. Toriyama and Futsuhara (1958) reported that estimated heritability values were higher for heading date and culm height than for panicle number and panicle weight. Oung and Chang (1958) and Chang (1960) also reported higher heritability estimates for heading date and plant height than for tiller number in crosses of rice involving irradiated progenies and their parents. Nei (1960) observed that in two hybrid populations of rice studied, the heritability estimates for heading date and culm length were higher than those for grain yield and number of panicles per plant.

Heritability values for yield and other plant characters have also been reported for soybean (Weber and Moorthy, 1952; Yu, 1963), corn (Warner, 1952), barley (Grafius *et al.*, 1952; Fiuzat and Atkins, 1953; Jogi, 1956; Kiriyama and Konishi, 1956; 1957), wheat (McNeal, 1960), oat (Frey and Norden, 1959), *Lespedeza* (Cope, 1962) and tobacco (Chang, 1962).

MATERIALS AND METHODS

Choung-Chin-Chiu and Chianung 242, both of the *japonica* type, were used as parents and the cross was made in the second crop of 1962. The former was chosen for its high tillering capacity and the latter for its large and heavy panicles. Each parent was considered to be genetically homozygous. F_1 seeds were grown in the first crop of 1963 for productin of F_2 seeds.

In the second crop of 1963, F_2 plants and parents were grown in randomized complete blocks with three replications. F_2 seedlings were grown under two treatments, i.e. spaced planting and bunch planting. In the conventional method of spaced planting, the distance between rows was 25 cm and the distance between hills within a row was 20 cm. One seedling was planted to each hill. In the bunch planting method, a total of four seedlings were planted around the area where in conventional method a seedling should be transplanted. Four seedlings, each placed approximately 4.5 cm appart, formed a square in which one seedling occupied a corner of the square. Plantings of both parents were made in the same way as space-planted F_2. One hundred plants for each of the parents and two hundred plants for each planting of F_2 were included in each replication.

Twenty plants were selected at random from both parents and both treatments of F_2's in each replication and the following data were recorded for each plant: heading date, plant height, number of panicles per plant, number of grains per panicle, length of panicle, weight of panicle, weight of 100 grains and grain yield per plant.

Since F_2 plants and their parents were grown in three replications, replication differences were removd in the analysis of variance. The resulting F_2 variance, therefore, contained the genotypic and environmental portions. The average error mean squares of the parents for each of the eight characters studied were used as the environmental variance in computing F_2 genotypic variances. Similarly, environmental covariances were derived from parental plants. The F_2 genotypic variance

for each character studied was calculated by subtracting the environmental variance from the total (but adjusted for replication differences) F_2 variance.

In this experiment, heritability in the broad sense was calculated from the following formula:

$$\text{Heritability} = \frac{V_{F2} - V_E}{V_{F2}}$$

V_{F_2} = total F_2 variance observed.

$V_E = 1/2\ (V_{P_1} + V_{P_2})$, where V_{P_1} and V_{P_2} are total variance of parent 1 and parent 2 observed, respectively.

Phenotypic, genotypic, and environmental correlations between two characters were calculated from the following formulas:

$$r_P = \frac{COVxy_{F2}}{\sqrt{Vx_{F_2} \cdot Vy_{F_2}}}$$

$$r_G = \frac{COVxy_{F_2} - COVxy_E}{\sqrt{(Vx_{F_2} - Vx_E)(Vy_{F_2} - Vy_E)}}$$

$$r_E = \frac{COVxy_E}{\sqrt{Vx_E \cdot Vy_E}}$$

r_P = phenotypic correlation coefficient.

r_G = genotypic correlation coefficient.

r_E = environmental correlation coefficient.

$COVxy_{F_2}$ = F_2 covariance between characters x and y.

$COVxy_E = 1/2\ (COVxy_{P_1} + COVxy_{P_2})$, where $COVxy_{P_1}$ and $COVxy_{P_2}$ are parent 1 and parent 2 covariances between characters x and y, respectively.

Vx_{F_2}, Vy_{F_2} = total F_2 variances observed in characters x and y, respectively.

$Vx_E = 1/2\ (Vx_{P_1} + Vx_{P_2})$, where Vx_{P_1} and Vx_{P_2} are total parent 1 and parent 2 variances observed in character x, respectively.

$Vy_E = 1/2\ (Vy_{P_1} + Vy_{P_2})$, where Vy_{P_1} and Vy_{P_2} are total parent 1 and parent 2 variances observed in character y, respectively.

A path-coefficient is simply a standardized partial-regression cofficient which permits the separation of the correlation coefficient into components of direct and indirect effects. In this paper, path-coefficients were calculated by following the abbreviated Doolittle method (Yeh, 1962).

EXPERIMENTAL PESULTS

Effect of Planting on the Character of F_2 Plants.

The means of eight agronomic characters measured are summarized in Table 1.

Table 1 shows that mean values for seven of the eight characters observed in bunch-planted F_2 plants were smaller than those of space-planted ones. The bunch planting greatly reduced the mean number of panicles, number of grains per panicle and grain yield per plant, but it caused only a slight reduction in heading date,

Table 1. Means of eight agronomic characters in the P_1, P_2, and F_2 plants of a rice cross, Choung-Chin-Chiu x Chianung 242

Characters	Choung-Chin Chiu(P_1)	Chianung 242(P_2)	F_2 space-planted	F_2 bunch-planted
Heading date (days)	56.42	61.30	53.05	52.28
Plant height (cm)	101.73	118.83	98.88	91.84
Number of panicles	12.35	7.42	10.85	4.82
Number of grains per panicle	75.55	133.20	82.82	59.29
Length of panicle (cm)	17.56	23.55	17.79	15.34
Weight of panicle (g)	2.08	3.62	2.23	1.52
Weight of 100 grains (g)	2.82	2.89	2.76	2.87
Grain yield per plant (g)	22.91	22.41	21.09	6.52

plant height and length of panicle, indicating that former characters were more easily affected by the environment than the latter ones. The average weight 100 grains in bunch planting was slightly higher than that of spaced planting, suggesting that this character was not affected by the change in planting method.

Estimates of Heritability.

Heritability in the broad sense for each character studied was calculated as the percent genotypic variance of the total F_2 variance. Table 2 shows the heritability estimates for eight characters of F_2 plants in the two planting treatments.

Table 2. Heritability estimates for eight agronomic character of F_2 plants in the spaced and bunch plantings.

Characters	Heritability (%)	
	Space-planted F_2	Bunch-planted F_2
Heading date	64.81	67.44
Plant height	61.38	68.28
Number of panicles	65.54	0
Number of grains per panicle	65.51	64.67
Length of panicle	61.17	78.50
Weight of panicle	31.90	42.50
Weight of 100 grains	50.57	38.57
Grain yield per plant	49.19	0

Heading date, plant height, number of grains per panicle and length of panicle showed comparatively high heritability values while those of weight of panicle and weight of 100 grains were relatively low. The heritability estimates for length of panicle, weight of panicle, plant height, and heading date increased by 17.33%, 10.60%, 6.90% and 2.63%, respectively under the condition of bunch planting. The heritabilities for weight of 100 grains and number of grains per head decreased by 12.00% and 0.84%, respectively when F_2 seedlings were

planted in bunches. Number of panicles and grain yield per plant in the bunch planting gave negative heritability values and these were replaced with 0.

Phenotypic, Genotypic, and Environmental Correlations.

Phenotypic, genotypic, and environmental correlations for all possible combinations are presented in Table 3.

Table 3 shows that genotypic correlations were, in general, higher than phenotypic correlations in both plantings of F_2 plants. Most of the phenotypic correlations of the bunch-planted F_2 plants were higher than those of the space-planted ones. Environmental correlations showed, on the whole, considerably smaller values than either the phenotypic or genotypic values to much larger for various character associations.

Genotypic and phenotypic correlation coefficients between any two characters had like signs in bunch planting. In the spaced planting, the positive phenotypic correlations between panicle length and weight of 100 grains, plant height and number of grains per panicle, and weight of panicle and weight of 100 grains became negative genotypic correlations, while the negative phenotypic correlation between heading date and grain yield per plant became positive genotypic correlation.

Phenotypic and environmental correlation were significant in most cases. For genotypic correlations, although appropriate tests of significance have not been developed, considerable variation in magnitude of the correlations was apparent. The highest positive phenotypic and genotypic correlations among the characters studied were found to be between number of grains per panicle and weight of panicle and between panicle length and heading date, respectively, while the highest negative phenotypic and genotypic correlations were obtained between number of panicles and weight of 100 grains, and between weight of 100 grains and grain yield per plant, respectively in the spaced planting. In the bunch planting, the highest positive correlations, both observed and genotypic, were found to be between panicle length and number of grains per panicle, while the highest negative phenotypic and genotypic correlations were obtained between heading date and weight of 100 grains and number of panicles and weight of 100 grains, respectively. For environmental correlations, number of grains per panicle and weight of panicle was most positively correlated, while heading date and grain yield per plant was most negatively associated.

Genotypic correlations between grain yield per plant and number of panicles and other attributes in bunch planting were not included because of the negative variances obtained for grain yield per plant and number of panicles in this planting treatment. The genotypic correlation coefficients involving panicle weight with several other characters exceeded unity in either the positive or negative directions. Hence, they were excluded from the table.

Path-Coefficient Analysis.

Four variables, i.e. number of panicles, number of grains per panicle, weight of

Table 3. Phenotypic, genotypic and environmental correlation coefficients between characters of space-and bunch-planted F_2 populations

Characters correlated	Correlation coefficients				
	Space-planted F_2		Bunch-planted F_2		r_E
	r_P	r_G	r_P	r_G	
Panicle length and					
plant height	0.6222**	0.6180	0.7323**	0.7770	0.6260**
heading date	0.5205**	0.9280	0.2941*	0.4668	−0.1721
number of panicles	−0.1734	−0.3607	0.1696	—	0.1502
number of grains per panicle	0.8219**	0.8796	0.9022**	0.9856	0.7244**
weight of panicle	0.8187**	—	0.8955**	—	0.6266**
weight of 100 grains	0.0065	−0.0962	−0.0646	−0.2078	0.0137
grain yield per plant	0.2875*	0.1586	0.6194**	—	0.4515**
Plant height and					
heading date	0.4838**	0.9244	0.3263**	0.6066	−0.2656*
number of panicles	0.0890	−0.0649	0.0742	—	0.3568**
number of grains per panicle	0.6610**	0.7069	0.8152**	0.9332	0.5828**
weight of panicle	0.5860**	0.6081	0.8146**	—	0.6183**
weight of 100 grains	−0.0768	−0.2049	−0.0763	−0.2224	0.0857
grain yield per plant	0.3608**	0.1922	0.7141**	—	0.5761**
Heading date and					
number of panicles	−0.2667*	−0.2608	0.1540	—	−0.2778*
number of grains per panicle	0.3731**	0.6999	0.3116*	0.5942	−0.2381
weight of panicle	0.3451**	—	0.3472**	0.8831	−0.2889*
weight of 100 grains	0.0120	0.1501	−0.6045**	—	−0.1775
grain yield per plant	−0.0170	0.2763	0.1122	—	−0.4092**
Number of panicles and					
number of grains per panicle	−0.0518	−0.2046	0.0323	—	0.2386
weight of panicle	−0.1028	−0.0375	−0.0530	—	0.1770
weight of 100 grains	−0.3227*	−0.4714	−0.2384	—	−0.1241
grain yield per plant	0.7402**	0.7099	0.5228**	—	0.8048**
Number of grains per panicle					
weight of panicle	0.9482**	—	0.8650**	0.9449	0.8200**
weight of 100 grains	−0.0583	−0.1653	−0.1465	−0.3773	0.0893
grain yield per plant	0.4399**	0.3107	0.7475**	—	0.6296**
Weight of panicle and					
weight of 100 grains	0.0962	−0.2873	0.3941**	0.4380	0.3647**
grain yield per plant	0.4151**	0.0646	0.7474**	—	0.6623**
Weight of 100 grains and					
grain yield per plant	−0.2820*	−0.6480	−0.1600	—	0.0823
Degree of freedom	58		58		58

* Correlation coefficients significant at the 5% level.
** Correlation coefficients significant at the 1% level.

100 grains, and grain yield per plant, were included in the path-coefficient analysis to partition phenotypic correlation coefficients. The interrelationships of (1) number of panicles, (2) number of grains per panicle, (3) weight of 100 grains, and (4) grain yield per plant are shown diagramatically in Figures 1 and 2 for space-and bunch-planted F_2 populations, respectively.

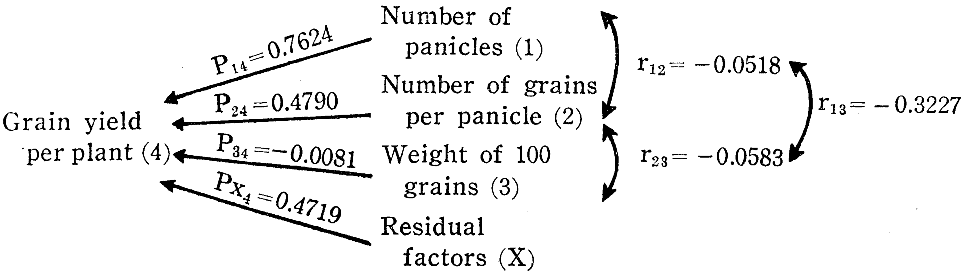

Figure 1. Path diagram and coefficients of factors affecting grain yield per plant in the space-planted F_2 population.

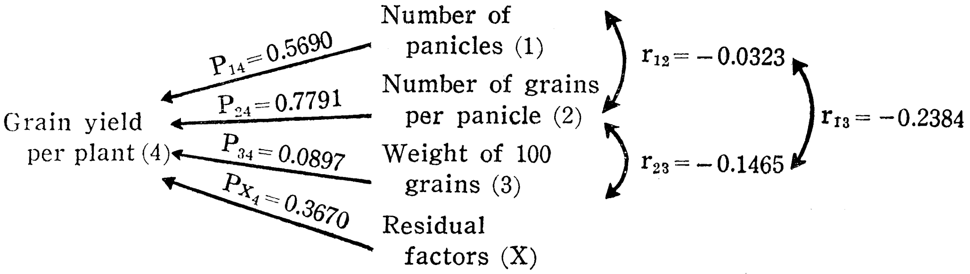

Figure 2. Path diagram and coefficients of factors affecting grain yield per plant in the bunch-planted F_2 population.

The double-arrowed lines indicate mutual association as measured by correlation coefficients. The single-arrowed lines represent direct effects in one direction measured by path coefficients. The residual variable (X) includes direct effects of all other factors affecting grain yield per plant in this experiment.

The diagrams shown in Figures 1 and 2 greatly facilitate the understanding of the nature of the cause and effect system. Figure 1 shows that the number of panicles was the most important agronomic character influencing grain yield per plant in the spaced-planting. The direct effect of unknown variables Px_4 was considerably high. Figure 2 reveals that the number of grains per panicle greatly influenced grain yield per plant in bunch-planted F_2 plants. The direct effect of unknown variables under the condition of bunch-planting was somewhat lower than that of the spaced one. Both diagrams indicate that the weight of 100 grains apparently had little to do with grain yield per plant in both plantings.

DISCUSSION

Heritability values for number of panicles and grain yield per plant were positive in the space-planted F_2 population, but they became negative in the bunch-

planted one because of their negative genotypic variances in the latter planting. It was found that in the bunch planting treatment, the ranges of variation for these two characters were much smaller than those of both parents. Consequently, the total observed variances of these two characters were smaller than those of parental means. The results indicated that variability of these two characters was highly susceptible to the masking or modifying effect of the bunch planting. A similar observation was also made by Karia and Yamamoto (1963). The other characters studied were comparatively less affected by the environmental factors. As a result, considerably higher heritability estimates were obtained for these characters, particularly in the bunch planting of F_2 population. The heritability estimates made in this experiment were, in general, similar to the results reported for rice (Bollich, 1957), barley (Fiuzat and Atkins, 1953), soybean (Yu, 1963), and many other crops.

In this experiment, a total of 60 plants each for both parents and the two plantings of F_2 were used for calculating environmental and phenotypic variances and covariance. The erratic and inconsistent heritability estimates for grain yield per plant and number of panicles seemed to indicate that more plants should be included for deriving heritability estimates, especially for the most variable attributes. Weber and Moorthy (1952) suggested that in soybean, 75 to 100 plants per parent would be more desirable for the estimates of heritability.

Under the condition of bunch planting, it was found that heritability values for length of panicle, plant height and heading date increased over those obtained under spaced planting, while those for number of panicles, grain yield per plant and weight of 100 grains showed a decrease. An increase in heritability value for plant height and a decrease for number of panicles in high planting density of rice plants were also observed by Kariya and Yamamoto (1963). Gotoh and Osanai (1959) reported that degree of heritability for a given character varies with growing conditions. Since degree of heritability is generally associated with efficiency of selection, the data seemed to indicate that effective selection could be made for certain characters under the conditions of bunch planting.

Heritability values for panicle length, plant height, heading date and number of grains per panicle were quite high in the bunch planting, suggesting that selection for these characters may be effective under this planting method. The genotypic correlation between panicle length and number of grains per panicle was positive and extremely high. From the examination of path-coefficients, it was revealed that number of grains per panicle was the most important character influencing grain yield per plant in bunch planting. In view of the extremely high positive association between panicle length and number of grains per panicle, and the decisive direct effect of number of grains per panicle upon the grain yield per plant, an indication seems to be that indirect selection for grain yield through panicle length could be an avenue for rapid progress. The positive and relatively high genotypic correlations between plant height and number of grains per panicle

would also be of value in individual plant selection for grain yield per plant.

In the space-planted F_2 population, number of panicles had the highest heritability value, indicating that selection for this character may be effective in this planting. It was observed that the number of panicles was highly and positively correlated with grain yield per plant. Path-cofficients showed that, in the spaced planting, grain yield per plant was determined primarily by the direct effect of panicle number. However, the high, positive association between panicle number and grain yield per plant probably would be of little value in selection because of generally low value of heritability found to be associated with number of panicles (Chang, 1960; Nei, 1960), and also the high positive environmental correlation coefficient observed between these two characters. Thus, the practice of indirect selection for grain yield through selection for panicle number does not appear promising.

The heritability for number of grains per panicle ranked next in the space-planted F_2 population. However, the genotypic correlation between number of grains per panicle and grain yield per plant was relatively low. The path-coefficients also indicated that, under the condition of spaced planting, the direct effect of number of grains per panicle on the grain yield per plant was only of secondary importance. As a result, the high association between number of grains per panicle and grain yield per plant may be of little practical value in selecting high yielding plants in the space-planted F_2 population.

The path-coefficient analysis indicated that the relationship of grain yield per plant with components of grain yield differed in the two plantings. Rumbaugh (1963) concluded that selection indices based upon yield component data obtained in spaced nurseris may not accurately portray the yield potentials of genotypes in solid seeding of alfalfa. Kariya and Yamamoto (1963) also reported that the best method for breeding rice varieties adapted to high planting density might be to conduct selection under the conditions of high planting density. It is apparent, therefore, that selection made in the bunch-planted F_2 population would contain more genotypes adapted to closely spaced growing conditions. Based on the observations of this study, a logical interpretation of the results seems to be that, under the conditions of this experiment, bunch planting appears to provide a favorable environment for effective selection of individual plants in the segregating F_2 population.

SUMMARY

Spaced and bunch plantings of F_2 plants of a cross between two *japonica* rice varieties, Choung-Chin-Chiu and Chianung 242, together with their space-planted parents, were arranged in randomized complete blocks to evaluate genetic and environmental variability of the segregating F_2 populations. Data recorded on each plant were heading date, plant height, number of panicles per plant, number of grains per panicle, length of panicle, weight of panicle, weight of 100 grains, and

grain yield per plant. Heritability values for each character and correlation coefficients between characters were calculated. Path-coefficient analysis was made to show the interrelationships of components of yield with grain yield per plant.

Bunch planting greatly reduced the average values of number of panicles and grain yield per plant, indicating that these characters were most easily affected by close spacing. The remaining characters studied were found to be less affected by the environmental variation. Means of weight of 100 grains in the two planting methods remained almost the same.

Heritability values for panicle length, weight of panicle, plant height, and heading date were higher in bunch planting than in the spaced one, while weight of 100 grains showed higher heritability value in spaced planting. The heritability estimates for the number of panicles and grain yield per plant were inconsistent in both plantings. Negative heritability estimates of these characters in bunch planting were due partly to the large environmental variance and partly to the unusually small phenotypic variance associated with these two characters.

Phenotypic correlations in bunch planting were found to be generally higher than those in spaced planting. Under each planting, genotypic correlations were mostly larger than phenotypic correlations. Positive associations involving number of grains per panicle with panicle length, plant height, and heading date were, in general, larger in bunch planting than those in the spaced one. Grain yield per plant was found to be highly correlated with number of grains per panicle in bunch planting, while in spaced planting, grain yield per plant was more closely associated with number of panicles.

From the examination of direct effects of components of yield on grain yield per plant, it was shown that the number of grains per panicle was the most important character influencing grain yield per plant in bunch planting, while in spaced planting, it was primarily the number of panicles that determined the grain yield per plant. Considering the magnitude of heritability and association of characters, it seems reasonable to conclude that bunch planting provides a more favorable environment for segregating F_2 populations in which effective individual plant selection could be made.

LITERATURE CITED

Akemine, H. and K. Kumagai. 1958. Variation and combination of characters in a cross between widely differing varieties of rice. *Studies on the Bulk Method of Plant Breeding*, Yokendo Ltd., Tokyo.

Bartley, B. G. and C. R. Weber 1952. Heritable and nonheritable relationships and variability of agronomic characters in successive generations of soybean crosses. Agron. J. *44* (9): 487–493.

Bollich, C. N. 1957. Inheritance of several economic quantitative characters in rice. Diss. Abs. *17*: 1638.

Chang, E. Y. 1962. The inheritance of some quantitative characters in *Nicotiana* tobacco. 1. Hicks x Kuo-fan. Taiwan Tobacco Res. Inst. Sp. Bull. No. 5.

Chang, W. T. 1960. Characteristics of X-ray induced mutations and their inheritance of rice. Jour. Agri. Assoc. China, New Series *29*:53–58.

Cope, W. A. 1962. Heritability estimates and correlations of yield and certain morphological and chemical components of forage quality in *Sericea Lespedeza*. Crop Sci. *2* (1): 10-12.

Dewey, R. D. and K. H. Lu. 1959. A correlation and path-coefficient analysis of components of crested wheatgrass seed production, Agron. J. *51*(9):515-518.

Elliot, F. C. 1958. *Plant breeding and Cytogentics*. McGraw-Hill Book Co. Inc. New York. 395 pp.

Fiuzat, Y. and R. E. Atkins. 1953. Genetic and environmental variability in segregating barley population. Agron. J. *45*(9):414-420.

Frey, K. J. and A. J. Norden. 1959. Lodging studies in oats. II. Inheritance and heritability. Agron. J. *51*(9):535-537.

Gotoh, K. and S. I. Osanai. 1959. Efficiency of selection for yield under different densities in a wheat cross. Jap. J. Breeding. *9*(1):7-11.

Grafius, J. E., W. L. Nelson. and V. A. Dirks. 1952. The heritability of yield in barley as measured by early generation bulked progenies. Agron. J. *44*(5):253-257.

Jogi, B. S. 1956. The heritability of agronomic and disease reaction characteristics in two barley crosses. Agron. J. *48*(7):293-296.

Juang, P. Y. 1962. On the planting method of testing sugarcane seedlings. I. the effect of bunch planting method on the selection of promising and vigorous growing seedling. Report Taiwan Sugar Exp. Sta. *27*:15-29.

Kariya, K. and T. Yamamoto. 1963. Planting density and selection method in rice plant. Jap. J. Breeding. *13*(1):25-30.

Kiriyama, T. and T. Konishi. 1956. Studies on the effect of selection in barley breeding-Heritability for agronomic characters. Kyushu Agr. Exp. Sta. Res. Bull. *4*(2):219-223.

——— and ———. 1957. Studies on the effect of selection in barley breeding. II. Heritability and genotypic correlations for the agronomic characters and their application to breeding. Kyushu Agr. Exp. Sta. Res. Bull. *4*(3):329-341.

Matsuo, T. 1956. Breeding method for high yielding rice varieties. Agr. & Hort. *31*(5):641-646.

McNeal, F. H. 1960. Yield components in a Lemhi x Thatcher wheat cross. Agron. J. *52*(6):348-349.

Nei, M. 1960. Studies on the application of biometrical genetics to plant breeding. Mem. Col. Agr. Kyoto U. *82*:1-100.

Oung, T. Y. and W. T. Chang. 1958. Mutations in rice induced by X radiation. Proc. 2nd International Conf. Peaceful Uses Atomic Energy, U. N., Geneva. (1958). *27*:223-226.

Rumbaugh, M. D. 1963. Effects of population density on some components of yield of alfalfa. Crop Sci. *3*(5):423-424.

Toriyama, K. and Y. Futsuhara. 1958. Estimates of heritabilities on individuals and lines in rice. Jap. J. Breeding. *7*:208-212.

Warner, J. N. 1953. A method for estimating heritability. Agron. J. *44*(8):427-430.

Weber, C. R. and B. R. Moorthy. 1952. Heritable and non-heritable relationships and variability of oil content and agronomic characters in the F_2 generation of soybean crosses. Agron. J. *44*(4):202-209.

Yang, C. S. 1957. A study on the competitive ability and yields among sugarcane varieties. Report Taiwan Sugar Exp. Sta. 16:37-48.

Yeh, S. F. 1962. *Experimental Designs. I. Biometrics*. Chinhua Press, Taipei, 276 pp.

Yu, C. H. 1963. Heritability and genotypic correlation of oil and agronomic characters in the F_2 generation of soybean crosses. Taiwan prov. Inst. Agr. Bull. 1963.

移植法對水稻雜交第二代後裔農藝性狀變異及相關之影響

張　萬　來

摘　要

日本型水稻中京旭與嘉農 242 號品種雜交第二代後裔分別依慣行單本植法與欉植法移植以測定不同移植法對雜交第二代後裔主要農藝性狀變異及相關之影響。慣行單本植法行距為 25 cm，株距 20 cm，每穴挿植秧苗一支。欉植法之行，株距同前，惟在前法植穴周圍挿植 4 支秧苗使成一欉，每欉內苗距 1 寸半見方，以防止生育後期欉內 4 單株之混雜。除 F_2 外，另加親本（單本植）參試，俾便估計環境變量。試驗設計採用隨機區組法，重複三次，每重複植株數，親本各為 100 單株，單本植 F_2 200單株，欉植 F_2 200單株（即50欉）。就每重複內各集團隨機選取 20 單株供為生育日數，株高，穗數，每穗粒數，穗長，穗重，谷百粒重，及谷產量等農藝性狀之調查。根據調查結果計算各性狀廣義遺傳力及兩性狀間之各種相關係數。至於產量構成因子與谷產量間之相互關係則以路徑係數加以說明，玆將所得結果摘要如下：

主要農藝性狀之平均值，欉植區僅谷百粒重高於單本植區，餘外諸性狀多因欉植而行減少，尤以穗數與谷產量為最，因此顯見，谷百粒重不受欉植影響，而穗數及谷產量對密植環境，特具敏感。

穗長，穗重，株高及生育日數之遺傳力，隨欉植而增加，但谷百粒重之遺傳力，却因欉植而減低，穗數與谷產量之遺傳力變化無常，其遺傳變量在欉植區變為負值，其原因可能由於環境變量較大，與該性狀在欉植環境下其表現型變量大為減低所致。

欉植區兩性狀間之表現型相關係數，多高於單本植區。在不同種植法之兩個集團，一般言之，遺傳型相關均高於表現型相關。每穗粒數與穗長，株高及生育日數等之相關，兩個 F_2 集團內均成極顯著之正相關，其相關係數，欉植區高於單本植區。在欉植區內，谷產量與每穗粒數之間有極顯著之正相關，而在單本植區，谷產量則與每株穗數成極顯著之正相關。

由路徑係數分析，得知欉植區內谷產量直接受每穗粒數之影響，而單本植區內，谷產量直接受每株穗數所牽制，綜合分析單本植與欉植區內 F_2 主要農藝性狀之遺傳力，相關係數與路徑係數，似可得一概念，即在欉植環境下行單株選拔時可能獲得高產，優良個體之機會，似較在慣行單本植情形下選拔時為大。

水稻宿根栽培方法之研究

（第二報） 品種間再生力及產量之變異

謝全份　　高樹　　江忠

一、緒　　言

宿根稻又名再生稻，卽收穫後由稻椿所發出萌芽培育栽培之特種栽培之一種。筆者（1949）曾作幾項試驗探討宿根稻之合理栽培方法，得知再生力之強弱與萌芽發育之良否直接影響產量甚大爲改良宿根稻之再生力，筆者自1957年起繼續探討再生力及產量之品種間差異以求適合宿根栽培用之品種。

茲將試驗結果分析整理本報告以供參考。本試驗進行期間承徐所長水泉指導，楊技士方平之協助，文成時承謝主任順景，多方斧正協助，併予致謝。

二、材 料 及 方 法

爲比較品種間再生力之差異特用目前臺灣推廣蓬萊種，15種爲主要品種，另外用二種在來種爲參考品種，茲將品種名稱，等列於第一表。

表一　供試品種之名稱特徵

品種代號	品　種　名	類　別	特　　徵	育成場所
1	臺中 65 號	蓬 葉 種	稈中、分蘖中、穗中、中性	臺中區改良場
2	臺中 150 號	〃	稈中、分蘖中、穗中、早生	〃
3	農育 1,804 號	〃	稈稍高、分蘖中、穗大、中生	農試所
4	農育 1,805 號	〃	〃　〃	〃
5	臺北 127 號	〃	稈中、分蘖中、穗中、中生	臺北區改良場
6	臺北 177 號	〃	〃　〃	〃
7	臺農 38 號	〃	稈中、分蘖多、穗小、中生	農試所
8	農育 1,830 號	〃	稈中〃分蘖中、穗中、中生	〃
9	薪竹 50 號	〃	〃　〃	薪竹區改良場
10	薪竹 56 號	〃	〃　〃	〃
11	嘉南 8 號	〃	稈中、分蘖中、穗中、稍晚	臺南區改良場
12	嘉農 242 號	〃	稈長、分蘖中、穗大、晚中	嘉義農業試驗分所
13	高雄 2 號	〃	稈中、分蘖稍多、穗中、中生	高雄區改良場
14	光復 401 號	〃	稈中、分蘖中、穗大、中生	臺中區改良場
15	嘉南 2 號	〃	稈高、分蘖稍小、穗大、晚生	臺南區改良場
	白末粉	在來種	稈中、分蘖中、穗中、中生	
	柳頭仔	〃	稈低、分蘖多、穗小、中生	

每品種種植5行，每行20株，行株距均爲 22.5 c.m.。小區面積 112.5 c.m.×450 c.m.＝5.06m^2。田間採用隨機排列設計，重複三次，並於每小區傍邊設一對照區卽同一品種之移植區，以供產量

之比較，各小區間不做田硬，移植稻在宿根稻椿刈除時挿秧之。

第一期作。普通方法栽培之，收穫時遺留 20 c.m. 高之稻椿並妥爲整齊刈取。稻收刈時注意勿隨意踐踏，以免影響再生力，田間常保持適宜水濕以免除草工作之困難。第二期作挿秧時即八月上旬舉行施肥，除草前將萌芽連舊稻椿距地面約三公分處割除培育宿根稻。

施用肥料公斤/公頃硫酸錏300，硫酸鉀100，過磷酸鈣300，硫酸錏在第一次及第二次除草時施用，其他田間管理照一般管理方法相同，其各耕作日期如下

表二　各種耕作日期表

期別 / 耕作別 / 年次	第一期作			宿根稻（第二期作）						
	播種	挿秧	收穫	割藁	施肥	第一次除草	第二次除草	第三次除草	害蟲防除	收穫
1957	1月22日	3月10日	7月14日	8月 9日	8月27日 9月 5日	8月27日	9月 5日	9月13日		11月22日
1958	1月18日	3月 6日	7月10日	8月16日	8月30日 9月 6日	8月30日	9月 6日	9月14日	9月 9日 9月15日	11月24日
1960	1月16日	3月 3日	7月 7日	8月14日	8月26日 9月 5日	8月26日	9月 5日	9月12日	9月 7日 9月16日	11月20日
1961	1月20日	3月24日	7月12日	8月 2日	8月18日 9月 4日	8月18日	8月26日	9月 4日	8月20日 8月27日	11月10日

三、試驗結果

(1)稻椿萌發率及，稈長、穗數之品種間差異。

舊稻椿刈除前將各小區調查各品種間之萌芽叢數及單株萌芽數之差異，到收穫前調查稈長及穗數，其結果如下表。

表三　稻椿萌芽率及稈長、穗數之品種間差異（三年平均）

品種名	萌芽叢數率	每叢萌芽率	稈長（公分）		穗數（支）	
			移植稻	宿根稻	移植稻	宿根稻
臺中 65 號	83.8(%)	8.7(%)	91.5	90.6	12.2	10.9
臺中 150 號	90.9	9.1	97.3	89.6	12.3	8.9
農育 1,804 號	90.2	9.5	99.2	89.9	9.6	8.5
農育 1,805 號	89.8	6.7	92.3	91.1	10.8	9.2
臺北 127 號	95.3	9.6	99.7	93.2	10.6	9.6
臺北 177 號	83.5	6.6	95.0	94.8	10.7	8.9
臺農 38 號	84.5	7.8	88.2	88.0	13.7	14.1
農育 1,830 號	95.3	8.6	92.9	87.8	10.3	9.3
新竹 50 號	97.6	10.2	102.5	88.2	10.5	9.0
新竹 56 號	88.3	8.2	97.3	90.8	11.3	10.3
嘉南 8 號	94.5	7.1	95.7	82.0	9.3	7.5
嘉農 242 號	51.5	3.1	101.9	92.4	10.3	8.3
高雄 27 號	80.8	6.4	92.3	91.1	11.3	11.6
光復 401 號	96.3	12.1	95.1	80,7	8.8	9.7
嘉南 2 號	97.3	8.3	97.0	96.6	11.1	9.8

觀表三可知新竹50號及嘉南 2 號萌芽叢數最多，嘉農 242 號最少，其他品種概有80—90%之餘

均有再生力，每叢芽數以光復401號及新竹50號最高每叢有10支以上，嘉農242號最少只有3支左右，農育1805號臺北177號高雄27號等均少。稈長移植稻均較宿根稻爲高，穗數以臺農38號，高雄27號，光復401號，等宿根稻均較移植稱爲多，可能因此品種缺株之影響，其他品種則宿根稻之穗數較移植少一、二枝。

(2)生育日數，抽穗期及成熟期之品種間變異。

表四 生育日數，抽穗期，成熟期之品種間變異（二年平均）

品種名	生育日數			抽穗日期			成熟期		
	移植稻	宿根稻	相差	移植稻	宿根稻	相差	移植稻	宿根稻	相差
臺中 65 號	55.0日	58.0日	— 7.0日	10月15日	10月 8日	— 7日	11月18日	11月10日	8日
臺中 150 號	59.5	50.0	— 9.5	10. 9	9. 30	—11	11. 11	11. 1	—10
農育 1,804 號	63.5	59.5	— 4.0	10. 14	10. 9	— 5	11. 16	11. 11	— 5
農育 1,805 號	65.5	58.5	— 7.0	10. 15	10. 8	— 7	11. 18	11. 10	— 8
臺北 127 號	64.0	59.5	— 5.5	10. 15	10. 9	— 6	11. 19	11. 11	— 8
臺北 177 號	64.5	60.5	— 4.0	10. 16	10. 10	— 6	11. 18	11. 11	— 7
臺農 38 號	67.5	61.0	— 6.5	10. 19	10. 11	— 8	11. 21	11. 11	—10
農育 1,830 號	65.0	60.0	— 5.0	10. 15	10. 10	— 5	11. 17	11. 10	— 7
新竹 50 號	63.5	60.5	— 3.0	10. 14	10. 10	— 4	11. 16	11. 11	— 5
新竹 56 號	65.0	61.0	— 4.0	10. 15	10. 11	— 4	11. 18	11. 12	— 6
嘉南 8 號	65.5	61.0	— 4.5	10. 16	10. 11	— 5	11. 19	11. 12	— 7
嘉農 242 號	66.0	61.5	— 5.5	10. 16	10. 12	— 4	11. 20	11. 14	— 6
高雄 27 號	68.0	64.0	— 4.0	10. 18	10. 14	— 4	11. 22	11. 16	— 6
光復 401 號	69.5	65.0	— 4.0	10. 20	10. 15	— 5	11. 24	11. 18	— 6
嘉南 2 號	71.0	68.5	— 2.5	10. 22	10. 17	— 5	11. 27	11. 22	— 5

表四中之生育日數者即表示宿根稻自舊稻椿刈除時至抽穗之期間，移植稻自揷秧至抽穗期間由表四可知，因品種不同而生育日數、抽穗期、成熟期，亦不同。移植稻生育日數短者宿根稻之生育日數亦較短。在一般而言宿根稻較移植稻早熟4—8天，此爲在移植稻揷秧同一時間整刈老稻椿並施肥培育者之相差日數倘在揷秧前提早擧行處理培育時可能相差更大。

(3)不同品種間稻谷產量之變異。

此將1959年及1961年由各小區所得產量紀錄分別整理經變量分析所得均方如下表

表五 產量變量分析表

年次	變因	自由度	平方和	均方	F值	理論 5%	理論 1%
1959	區組	2	49,617,778				
	品種	14	1,220,897,778	87,206,984	7.34**	2.12	2.90
	機差	28	332,515,555	11,875,555			
	合計	44	1,603,031,111				
1961	區組	1	5,720,334				
	品種	14	86,978,667	62,127,619	5.94**	2.53	3,80
	機差	14	14,644,666	10,460,476			
	合計	29	117,353,667				

不同品種間稻谷產量之差異，1959年與1961年相似極有顯著之差異，則宿根用之品種適否極有明顯。

各品種間產量之相差列於表六、七。

表六　1955年 各品種每 公斤/公頃 稻谷產量差異顯著性比較表

代號	品種															
6	臺北 177號	2,140														
15	嘉南 2號	1,973	167													
13	高雄 27號	1,660	480	313												
7	臺農 38號	1,613	527	360	47											
5	臺北 127號	1,493	647	480	167	120										
10	新竹 56號	1,460	680	513	200	153	33									
12	嘉農 242號	1,360	780	613	300	253	133	100								
8	農育 1830號	1,340	800	633	320	273	153	120	20							
2	臺中 65號	1,327	813	647	333	287	167	133	33	13						
3	農育 1804號	1,273	867	700	387	340	220	187	87	67	53					
1	臺中 150號	1,267	877	707	393	347	227	193	93	73	60	7				
4	農育 1805號	1,267	877	707	393	347	227	193	93	73	60	7	0			
9	新竹 50號	1,260	880	713	400	353	233	200	100	80	67	13	7	7		
11	嘉南 8號	1,040	1,100	933	620	573	453	420	320	300	287	233	227	227	220	
14	光復 401號	753	1,387	1,220	907	850	740	707	607	586	573	520	513	513	507	287

L. S. D. { 5% = 364.45 〰〰 ; 1% = 491.69 ——

表七 1961年 各品種每 公斤/公頃 稻谷產量差異顯著性比較表

代號	品種															
6	臺北 177 號	2,140														
10	新竹 56 號	2,100	40													
7	臺農 38 號	2,010	130	90												
4	農育 1805 號	1,810	330	290	200											
5	臺北 127 號	1,630	510	470	370	180										
3	農育 1804 號	1,620	520	480	380	190	10									
12	嘉農 242 號	1,610	530	490	390	200	20	10								
15	嘉南 2 號	1,480	660	620	530	330	150	140	130							
9	新竹 50 號	1,360	780	740	650	450	270	260	250	120						
13	高雄 27 號	1,350	790	750	660	460	280	270	260	130	10					
2	臺中 65 號	1,270	870	830	740	540	360	350	340	210	90	80				
1	臺中 150 號	1,260	880	40	750	550	370	360	350	220	100	90	10			
8	農育 1830 號	1,200	940	900	810	610	430	420	410	280	160	150	60	60		
14	光復 401 號	1,190	950	990	820	620	440	430	420	290	170	160	80	70	10	
11	嘉南 8 號	1,000	1,140	1,100	1,010	810	630	620	610	480	360	350	270	260	200	190

L. S. D. { 5% = 438.764 (wavy line) ; 1% = 608.951 (solid line)

表八　宿根稻與移植稻，稻谷產量比較 公斤/公頃

代號	品種＼栽培法	1959 年 宿根稻	1959 年 移植稻	1959 年 總計	1961 年 宿根稻	1961 年 移植稻	1961 年 總計
1	臺中 65 號	1,327	2,300	3,627	1,270	3,060	4,330
2	臺中 150 號	1,267	1,960	3,227	1,260	3,060	4,320
3	農育 1804 號	1,273	2,350	3,623	1,620	3,150	4,770
4	農育 1805 號	1,267	2,265	3,532	1,810	3,120	4,930
5	臺北 127 號	1,493	2,610	4,103	1,630	3,550	5,180
6	臺北 177 號	2,140	2,660	4,800	2,140	3,810	5,950
7	臺農 38 號	1,613	2,600	4,213	2.010	3,360	5,370
8	農育 1830 號	1,340	2,250	3,590	1,200	3,390	4,590
9	新竹 50 號	1,260	2,530	3,790	1,360	3,290	4,650
10	新竹 56 號	1,460	2,750	4,210	2,100	3,230	5,330
11	嘉南 8 號	1,040	2,540	3,580	1,000	2,630	3,630
12	嘉南 242 號	1,360	2,350	3,710	1,610	3,110	4,720
13	高雄 27 號	1,660	2,548	4,208	1,350	3,270	4,620
14	光復 401 號	753	2,060	2,813	1,190	3,700	4,890
15	嘉南 2 號	1,973	3.350	5.323	1,480	3,590	5,070
	統計	21,226	37,123	58,349	23,030	49,320	72,350

各品種間宿根稻之平均產量與移植稻之產量比較，經變量分析所得均方如下表。

表九　變方分析表

年次	變異原因	自由度	平方和	均方	F 值	理論 5 %	理論 1 %
1959	品種	14	2,665,715	190,408	5,579**	2.53	3.80
	栽培法	1	842,382	840,382	24,681**	4.60	8.86
	機差	14	477,826	34,130			
	總計	29	3,985,923	137,446			
1961	品種	14	2,044,467	146,033	2,193*		
	栽培法	1	23,038,804	23,038,804	345,949**		
	機差	14	932,346	66,596			
	總計	29	26,015,617	897,090			

觀表九可知1959年及1961年，品種，及栽培法之差異極顯著，就中栽培法最甚，明顯品種間宿根栽培之產量不及移植栽培甚鉅

四、考　　察

在本研究中注意到品種間再生力強弱之差異，此種再生力強弱將決定該品種之缺株以及是否適作宿根栽培之問題。萌芽數之多寡對稻株之留存有決定性之影響，萌芽數少者易因環境影響而死亡成爲缺株。另外是在萌芽枝以後生長齊度問題，株間之萌芽數相同，但以後生育不整齊者產量大爲減低，反之萌芽枝能的整齊生長者產量必高，故如何促進萌芽率並將萌芽枝培養旺盛在宿根稻栽培

上爲最重要之技術問題。

本試驗各種之萌芽叢數，每叢芽數，或收穫前一叢之穗數等點觀之其產量未依穗數，多而增產査其原因爲穗太小且結實不好直接影響單位面積之粒數進而影響其產量之故。如表六、七，所表品種間產量之差異極顯著。尤如高產之臺北177號與低產之新竹50號兩者最爲明顯。此種情形表示品種間對於宿根培培似有適否特性存在。本試驗供試十五品種中具有如上記之宿根特性之品種甚少，故一般品種宿根往往產量不及移植稻。

據王啓柱氏（1955）甘蔗早熟品種由於蔗苗萌芽率及蔗頭，萌發率之較高，莖長及莖徑之發育較爲充分，在新植及宿根栽培皆較中熟，尤其晚熟品種爲優。原料莖產量，早熟品種在新植方面平均超過中熟及晚熟品種達5.96%及7.23%而宿根方面則高達27.92%及33.32%因此早熟品種在臺灣中部蔗區比中晚，品種宜於新植，尤適於宿根栽培。本試驗中將早熟與晚熟品種間與再生力或與產量概無顯著之差異。尤其產量早熟品種反之低產之傾向，此點水稻與甘蔗不同之處。似因生育環境不同之故。

水稻品種的再生力之強弱與形態上似有差異，據在田間觀察結果

①前生稻稈之強弱與再生力有影響，弱稈品種容易倒伏，易罹紋枯病、菌核病，此種稻椿到成熟期大部之稻根成爲老敗槪失再生力，或將近枯死，成爲缺株之主要原因。如白米粉，嘉農292號之稈均較軟弱易倒伏，尤其後者易罹紋枯病，其稻椿槪失再生力，因卽缺株甚鉅，故認爲不適於宿根栽培。

②前生稻自抽穗至成熟所需日數因品種而不同其相差日數爲1—6天左右。抽穗日數越短者，愈快黃變，長者比較晚，此種情形與再生力似有關係，卽快黃變的品種其再生力比較弱，究其原因稻根早期老敗，極端者均無再生力，此種品種須需提早收穫或於收穫前促生新根防失萌芽。成熟所需日數長的品種與此相反再生力比較強。同一品種若在不同耕種條件之下栽培亦有差異，卽淺耕少肥者成熟所需日數短亦快黃變，深耕多肥者有相反之傾向，此種情形在宿根栽培上亦值得考慮。

總而言之選擇宿根栽培之品種需要預先觀察上述各種形態檢查其再生力，然後選用具有宿根能力之特性之品種爲要。

五、摘　　要

1. 爲探討水稻收刈後之再生力及產量之品種間差異乃利15種蓬萊種及兩種在來種進行田間試驗結果認爲有生育日數長的品種再生力較強。
2. 一般而言移植稻之稈長較宿根稻爲高其穗數亦較宿根稻多1—2支。
3. 生育日數均以宿根稻爲短，移植稻爲長相差日數7—10天。
4. 本試驗供試品種範圍內稻谷收量均以移植稻爲高宿根稻皆低，兩者之差異甚爲顯著。
5. 宿根栽培品種間產量之差異在統計上極爲顯著其最高品種與最低品種之相差達40--50%之鉅。

六、參　考　文　献

（1） 平島寅雄著（1951）栽培學（耕種編）

（2） 安田貞雄著（1930）植物生理學的栽培學汎論。

（3） 麻生慶次郞著（1920）植物生理化學。

（4） 汪呈因（1954）臺灣再生稻栽培之研究（臺灣農林8卷8期）

（5） 石田良弘（1932）株出の生育に關する研究（臺灣農事報370號

（6） 王啓柱（1955）甘蔗品種新植與宿根栽培之比較研究（中華農會報新第10期）

（7） 謝全份（1959）水稻宿根栽培方法之研究（農業研究第8卷3•4期）

（8） 未永仁（1931）臺灣農事報27（11）

STUDIES ON THE CULTIVATION OF RATOONED RICE
Varietal Variation on Ratooning Ability and Yield

by

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SUMMARY

1. Fifteen "ponlai" and two "native" varieties of rice were used for studies of varietal variation in ratooning ability and yield. It was found that the varieties with longer growing days tended to have stronger ratooning ability.

2. Generally speaking, culm height and number of ears in transplanted rice are larger than those of ratooned rice.

3. The number of growing days in ratooned rice was 7–10 days earlier than that of transplanted rice.

4. Significant difference between yields of transplanted and ratooned rices was found. The former was found to be higher in yield than the later.

5. Significant difference in yield among varieties of ratooned rice was found. 40–50% difference was seen in the heighest and the lowest classes.

甘藷品種「冲繩100號」引種經過及試驗成績

簡　金　寬

一、前　　言

臺灣甘藷栽培面積約23萬公頃，年產約 290 萬公噸，爲僅次於水稻之主要作物，近年來畜產發達，飼養猪牛頭數急增，而對於周年生甘藷之供應更爲迫切。按本省主要甘藷栽培季節多爲秋作，因之甘藷生產集中春夏季，惟本省夏季氣候氣溫較高，致使甘藷塊根不耐久貯，雖然可製成乾簽貯藏也難免秋冬生甘藷供應靑黃不接，因此春季栽植甘藷供應秋冬仍極需要。春作甘藷氣候環境特殊，生育期中遭遇高溫多雨，適合於秋季之優良品種未必適合於春季栽培，所以適合春季栽培品種之獲得尤感重要。光復後嘉義農業試驗分所，曾由國內外各地徵得甘藷品種數十種，除期以獲得優良親本，供雜交育種之材料外，觀察結果，其中冲繩 100 號尤適於春季栽培，經歷年各地試作情形也證明該種在各地之適應力強，願將該品種介紹於後藉供參考尚祈農界賜予指正。

二、來源及引種經過

冲繩 100 號係1928年在日本，冲繩縣立農事試驗場以七福爲母本與潮州爲父本雜交育成，經六年之淘汰選拔，1924年五月由日本農林省命名爲「冲繩 100 號」(1)，民國30年由日本首先引入我國，民國37年10月29日由嘉義農業試驗所從南京中央農業試驗所引進本省(2)，民國37年除加入品種保存以外，曾於37年－39年觀察三年(3)，民國42年—44年夏季品種比較試驗(4)，民國46年—47年首先加入全省甘藷春季區域試驗(5)，民國49年復加入全省春季區域試驗(6) 同時於民國 47年—49 年開始加入甘藷新品種地方試作，目前已在本省北部及澎湖部份推廣中(7)。

三、形 態 及 特 殊

(一)形態：葉形爲三淺裂葉，莖中部以下爲紫色，先端幼嫩部爲綠色，有毛，塊根短紡錘形有縱溝，皮色淡紅，肉黃色。

(二)特性

1. 早　　熟：耐濕而不耐旱，耐寒性較弱，春季挿植五個月後卽可收獲。
2. 適於春作：嘉義農業試驗所曾在民國42年—44年夏季品種比較試驗均於四月挿植，九月收獲，每公頃塊根產量達 14,000—18,000 公斤左右，春季區域試驗結果，塊根產量曾有十二處達 20.000 公斤以上。在春季新品種試作結果也獲得 28 次塊根根產量達20,000 公斤以上。
3. 適應性大：冲繩 100 號經民國46年—49年全省春季甘藷區域試驗31次及民國47年—49年春季甘藷新品種試作63次，結果塊根產量極大多數地方均有優良成績表現。
4. 抗　　病：本省甘藷生育期間植株所發生之主要病害爲蔓割病與縮芽病二種，冲繩 100 號雖未經人工接種，測驗其抗病力，一般觀察極少感染。
5. 品質優良：冲繩 100 號之製簽率高，普通爲 33—40 %，平均約爲37%澱粉率爲 17.8 %左右。

四、試驗結果及討論

一、甘藷品種保存試驗與甘藷引進品種特性觀察試驗：

冲繩100·號於民國38年—39年加入春季品種保存及秋季新引進品種特性觀察試驗二年，結果春季塊根產量略高於秋季產量，玆將試驗結果列表如下：

表一 冲繩100號春季塊根產量製簽量比較表（公斤/公頃）

Table 1. The yields of Tuber, Dry Chip and the Chip Percentage of Okinawa No, 100 in Spring Plantation Compared with those in Autumn Plantation.

季別 Season	莖葉產量 Yield of Green Parts	塊根產量 Tuber Xield	製簽率% Chip Percentage (%)	製簽量 Dry Chip Yield	食味 Taste	備註
春季 Spring	25,300	20,955	36.4	7,627	中中	甘藷品種保存試驗
秋季 Autumn	18,900	19,920	34.8	6,932	中中	甘藷新引進品種特性觀察試驗

二、夏季品種比較試驗：

本試驗於民國42年—44年間舉行，供試品種爲七十日早，過溝浪，紅心尾，嘉義種，臺農17號，48號，51號，冲繩100號，南瑞苕，普利苕等十品種，田間規劃採逢機排列法，重複四次，試驗結果冲繩100號塊根產量及製簽量均居首位，且顯著超過其他品種，玆將三年結果列表如下：

表二 夏季品種比較試驗塊根產量及製簽量比較表（公斤/公頃）

Table 2. The yields of Tuber and the Chip Percentage of Okinawa No. 100 Compared with the other Summer Planting Varieties in the Summer Season Varietal Test at Chiayi in 1953-55

品種 Variety	塊根產量 Tuber Yield				莖葉產量 Yield of greer parts	製簽率% Chip percentage	製簽量 Dry Chip yield	食味 Paste
	42年 1953	43年 1954	44年 1955	三年平均 average				
七十日早	16,560	20,370	10,695	15,905	22,231	29.5	4,691	中下
過溝浪 Kuo Kou lan	10,800	14,895	10,095	11,971	22,430	31.8	3,793	中下
紅心尾 Hung Sin Wei	18,705	9,300	10,080	12,695	28,956	23.9	3,034	中下
嘉義種 Chia Yi	10,425	6,945	1,740	6,370	20,789	28.7	1,828	中下
臺農17號 Tainung No. 17	13.470	10,485	9,240	11,065	18,270	39.7	4,392	中中
臺農48號 Tainung No. 48	10,440	9,780	5,175	8,465	32,448	29.8	2,522	中中
臺農51號 Tainung No. 51	9,780	15,075	9,945	11,600	23,156	29.3	3,398	中下
冲繩100號 Okinawa No.150	14,335	18,270	16,125	16,243	19,903	37.9	6,156	中中
南瑞苕 Nanoy Hall	9,360	13,170	11,565	11.365	17,273	35.2	4,000	中上
普利苕 Porto Rico	7,695	9,485	8,910	8,880	12,448	34.5	3,063	中上

三、區域試驗（A）

本品種於民國46年—47年加入區域試驗地點爲頭城，臺北、新竹、南投、臺中、嘉義、屏東、新園、澎湖、臺東、鹿野、花蓮等12地區，其他供試品種尙有臺農58號、51號、53號、56號、48號、17號、45號、新竹1號及對照種等共10個品種田間規劃爲逢機排列，重複四次，經試驗分析結果頭城、臺北、新竹、嘉義、屏東、新園、澎湖等七地區之冲繩100號塊根產量均超過對照種5%左右，玆將二年結果列表於下：

表三　春季甘藷全省區域試驗塊根產量比較表（公斤/公頃）

Table 3. Tuber Yields of some new varieties of sweet potatoes in the regional trial on the whole island in 1957-1959.

地點 Lacality / 品種 Variety	頭城 Tou cneng	臺北 Tai pei	新竹 Hsin chu	南投 Nan tou	臺中 Tai chung	嘉義 Chia yi	屏東 ping Tung	新園 Hsin yuan	澎湖 Peng hu	臺東 Tai tung	鹿野 Lu yon	花蓮 Hua lien	次數 order
臺農58號 Tai Nung No. 58	23,205 157.8	27,465 157.4	13,145 106.4	26,350 81.9	23,640 73.5	7,390 50.8	18,455 94.0	11,475 86.6	3,470 60.2	33,140 89.9	20,085 77.0	24,450 100.0	3
臺農51號 Tai Nung No. 51	19,760 134.4	17,980 103.0	12,220 98.9	27,870 86.4	29,005 90.2	12,270 84.3	16,360 83.4	11,435 86.3	7,280 126.4	31,455 85.3	29,640 113.6	20,560 84.1	3
臺農53號 Tai Nung No. 53	18,875 128.4	17,600 100.9	11,185 90.6	27,300 84.8	27,030 84.0	15,660 107.6	15,485 78.9	7,815 59.0	3,630 63.0	31,615 85.8	26,655 102.2	17,970 73.5	4
臺農56號 Tai Nung No. 56	23,270 158.2	19,060 109.2	5,080 41.1	21,220 65.9	20,520 63.8	5,365 36.8	8,375 42.7	3,680 27.8	1,910 33.2	29,500 80.0	28,375 10.8	24,235 99.2	3
臺農48號 Tai Nung No. 48	17,725 120.5	12,915 74.0	13,110 106.1	20,290 63.0	18,235 56.7	6,010 41.8	8,750 44.6	6,045 45.6	7,820 135.8	18,195 49.4	24,360 93.4	11,680 47.8	3
臺農17號 Tai Nung No. 17	14,540 98.9	16,515 94.6	9,755 79.0	20,130 62.5	21,015 65.4	8,485 58.3	15,635 79.7	6,085 45.9	6,120 106.2	26.005 70.5	16,990 65.1	17,615 72.1	1
新竹1號 Hsin Chu No. 1	23,950 162.9	16,945 97.1	14,945 121.0	2,560 78.2	30,615 95.2	13,900 95.5	16,295 83.0	1,232 92.9	1,990 173.4	30,360 82.4	24,210 92.8	19,555 80.0	3
臺農45號 Tai Nung No. 45	23,320 158.6	22,500 129.0	22,625 183.2	27,375 85.0	24,060 74.8	14,130 97.0	17,450 88.9	13,050 98.4	13,610 236.3	31,720 86.0	25,475 97.7	23,675 96.9	4
冲繩100號 Okinawa No. 100	23,180 157.6	20,740 118.9	13,940 112.9	23,850 74.1	25,755 80.1	16,395 112.6	20,610 105.0	15,200 114.7	7,130 123.9	29,800 80.8	23,645 90.6	21,840 89.4	7
對照種 Check	14,700 100.0	17,440 100.0	12,345 100.0	32,170 100.0	32,155 100.0	14,560 100.0	19,625 100.0	13,255 100.0	5,760 100.0	36,865 100.0	26,085 100.0	24,435 100.0	

備註：次數係表示塊根產量超過對照種次數。

區域試驗（B）

本試驗於民國49年春季擧行，試驗地點爲宜蘭、臺北、臺中、南投、屏東、臺東、花蓮等七地區，供試品種爲 P10 新竹1號、臺農45號、56、57號、58號、冲繩100號及對照種等八個品種田間規劃爲逢機排列，重複四次，經試驗分析結果，除宜蘭臺東二處冲繩 100 號塊根產量不及於對照種，其他各處塊根產量均較對照種增加15%—110%左右，各地製簽量則均超過對照種15%—220%左右。玆將試驗結果列表如下：

表四　春季甘藷全省區域試驗塊根產量及製簽量比較表（公斤/公頃）

Table 4. Tuber yields and dry chip yields of some new varieties of sweet potatoes in the regional trial on the whole island in 1960

地點 Locality / 項目 Item / 品種 Variety	宜蘭 I-lam 塊根產量 Tuber	宜蘭 I-lam 製簽量 Drychip	臺北 Tai Pei 塊根產量 Tuber	臺北 Tai Pei 製簽量 Drychip	臺中 Tai chung 塊根產量 Tuber	臺中 Tai chung 製簽量 Drychip	南投 Nan tou 塊根產量 Tuber	南投 Nan tou 製簽量 Drychip	屏東 Ping tung 塊根產量 Tuber	屏東 Ping tung 製簽量 Drychip	臺東 Tai tung 塊根產量 Tuber	臺東 Tai tung 製簽量 Drychip	花蓮 Fua line 塊根產量 Tuber	花蓮 Fua line 製簽量 Drychip
P10	24,000 86.9	6.240 90.4	6,743 137.0	1,652 154.1	21,960 114.1	5,182 136.1	18,244 130.8	4,433 164.0	11,175 84.1	2,894 77.8	31,785 96.8	8,486 107.3	16,785 107.1	5,488 166.9
新竹1號 Hsinchu No. 1	14,250 51.6	3,633 52.6	6,645 131.4	1,842 171.8	19,710 102.4	4,730 124.2	21,820 156.5	5,978 221.1	15,405 116.0	4,467 120.1	24,930 75.9	6.731 85.1	17,205 109.8	5,712 173.7
臺農45號 Tai Nung No. 45	24,600 89.1	7,257 105.1	2,990 81.0	1,129 105.3	23,445 121.9	5,931 155.7	20,995 150.6	5,962 220.5	14,775 111.2	4,713 126.7	33,150 101.0	10,011 126.6	16,095 102.7	5,472 166.4
臺農56號 Tai Nung No. 56	20,400 73.9	6,630 96.0	2,273 46.1	590 55.0	21,570 112.1	5,716 150.1	12,456 89.3	3,985 147.4	12,615 95,0	4,251 114.3	17,790 54.2	5,497 69.5	16,950 108.2	6,017 182.9
臺農57號 Tai Nung No. 57	16,950 61.4	4,322 62.6	8,925 181.4	2,445 228.0	26,550 138.0	6,690 175.7	19,240 138.0	5,367 198.5	15,690 118.1	4,816 129.5	36,330 111.6	10,476 132.5	17,640 112.6	6.050 184.0
臺農58號 Tai Nung No. 58	15,900 57.6	4,134 59.9	14,280 290.2	3,827 356.9	13,815 71.8	2,804 73.6	9,504 68.1	2,271 84.0	18,225 137.2	5,011 134.8	34,905 106.4	8,900 112.5	16,380 104.5	4,504 136.9
冲繩100號 Okinawa No. 100	23,250 84.2	8,137 117.9	10,433 212.0	3,526 328.9	25,710 133.6	7,995 210.0	24,270 174.1	8,494 314.2	15,810 119.0	5,296 142.5	31,065 94.6	11,245 142.2	18,405 117.5	6,165 187.5
對照種	27,600 100.0	6,900 100.0	4,920 100.0	1,072 100.0	19,230 100.0	3,807 100.0	13,938 100.0	2,703 100.0	13,275 100.0	3.717 100.0	32,805 100.0	7,906 100.0	15,660 100.0	3,288 100.0
對照種名稱	七十日早		七十日早		紅心尾		紅心尾		恒春種		半天良		紅心尾	
L. S. D. 5 %	3206.16		2658.26		3691.63		5726.57		3015.92		4044.92		642.44	
L. S. D. 1 %	4363.78		3618.05		5024.52		7794.20		4104.85		5505.40		874.40	

四、春季試作成績：

冲繩 100 號於民國47年同時加入春季地方試作，由各農業改良場負責執行，至49年春季供試作 63 處，試作結果冲繩 100 號塊根產量雖有 15 處不及於對照種，其他各處塊根產量均比對照種增加 1%—130%左右，在竹山試作結果塊根產量竟比紅心尾增收 480 %，各地製簽量僅有一處不及於對照種，其他各處則均超過對照種 5%—200%左右，由此獲知冲繩100號極適於全省各地春季栽培，玆將試作結果列表如下。

表五　冲繩100號春季試作塊根產量及製簽量比較表（公斤/公頃）

Table 5. The yields of tuber, dry chip and the chip percentage of Okinawa No. 100 compared with the check varieties in Spring olanting trial.

試作地點		年期	塊根產量			製簽率 %		製簽量（公斤/公頃）			對照種	插植期	生育時期
			冲繩100號	對照種	名次	冲繩100號	對照種	冲繩100號	對照種	名次	代號		
宜蘭	頭城	1959	21,500 (134.0)	16,000 (100.0)	1	32.5	26.0	6,988 (168.0)	4,160 (100.0)	1	A	五月中旬	155
	冬山	1959	25,100 (106.0)	23,600 (100.0)	1	31.8	24.8	7,982 (136.0)	5,853 (100.0)	1	A	五月中旬	160
	三星	1960	33,400 (96.0)	34,800 (100.0)	3	32.0	25.0	10,688 (123.0)	8,700 (100.0)	1	A	三月下旬	197
	蘇澳	1960	14,700 (130.0)	11,300 (100.0)	1	31.5	26.0	4,631 (158.0)	2,938 (100.0)	1	A	五月上旬	194
臺北	三峽	1959	12,600 (126.0)	10,000 (100.0)	2	36.0	25.6	4,536 (177.0)	2,560 (100.0)	1	A	五月中旬	15(
	樹林	1959	17,000 (210.0)	8,100 (100.0)	3	36.0	26.0	6,171 (293.0)	2,102 (100.0)	2	A	五月上旬	151
	新莊	1959	15,400 (132.0)	11,700 (100.0)	3	35.9	25.3	5,529 (187.0)	2,960 (100.0)	2	A	五月上旬	151
	士林	1960	18,000 (143.0)	12,600 (100.0)	4	36.5	27.7	6,570 (188.0)	3,490 (100.0)	3	A	五月中旬	193
	五股	1960	11,500 (84.0)	13,600 (100.0)	5	32.9	26.0	3,784 (107.0)	3,536 (100.0)	4	A	五月上旬	194
	深坑	1960	10,600 (82.0)	13,000 (100.0)	4	33.3	26.4	3,530 (103.0)	3,432 (100.0)	2	A	五月中旬	186
	景美	1960	8,430 (103.0)	8,100 (100.0)	4	34.9	25.7	2,932 (141.0)	2,082 (100.0)	4	A	五月中旬	189
桃園	龜山	1959	26,460 (124.9)	21,180 (100.0)	2	32.0	25.0	86,167 (159.9)	5,095 (100.0)	1	A	五月下旬	153
	龍潭	1959	12,000 (104.3)	11,500 (100.0)	1	33.0	25.0	3,960 (137.7)	2,875 (100.0)	1	A	五月下旬	154
	八德	1960	6,900 (102.2)	6,750 (100.0)	2	30.5	25.0	2,104 (124.7)	1,687 (100.0)	2	A	六月上旬	150
	楊梅	1960	18,271 (109.0)	16,753 (100.0)	2	32.0	25.5	5,846 (136.8)	4,272 (100.0)	2	A	六月上旬	149
新竹	湖口	1959	4,600 (76.0)	6,000 (100.0)	3	31.0	25.0	1.426 (95.0)	1,500 (100.0)	2	A	五月中旬	153
	竹北	1960	15,700 (83.00)	18,900 (100.0)	4	31.0	23.0	4,867 (119.0)	4,347 (100.0)	3	A	五月中旬	151
苗	大湖	1959	16,720 (102.0)	16,380 (100.0)	3	31.0	26.0	5,183 (121.7)	4,258 (100.0)	3	A	五月下旬	152
	通霄	1959	19,920 (95.8)	20,780 (100.0)	4	41.0	34.0	8,167 (115.5)	7,065 (100.0)	1	A	五月中旬	151

栗	三灣	1960	33,740 (85.8)	39,300 (100.0)	4	30.0	24.0	10,122 (107.3)	9,432 (100.0)	3	A	六月上旬	152
	南壯	1960	8,400 (168.0)	5,000 (100.0)	2	37.0	31.0	3,108 (200.5)	1,550 (100.0)	1	A	六月上旬	152
	龍井	1959	16,200 (92.6)	17,500 (100.0)	3	39.4	23.9	6,383 (152.6)	4,183 (100.0)	1	B	四月下旬	144
臺中	清水	1959	5,490 (124.5)	4,410 (100.0)	2	36.8	21.6	2,020 (212.0)	953 (100.0)	2	C	四月下旬	140
	新社	1960	29,720 (74.9)	39,680 (100.0)	4	37.0	22.7	10,996 (122.1)	9,007 (100.0)	1	C	三月上旬	147
	太平	1960	13,200 (250.0)	5,280 (100.0)	2	36.0	20.8	4,752 (432.9)	1,098 (100.0)	2	C	三月上旬	160
	北區	1959	18,740 (154.5)	12,130 (100.0)	2	32.3	21.7	6,053 (230.0)	2,632 (100.0)	2	C	四月下旬	158
	北區	1960	14,220 (152.1)	9,350 (100.0)	2	32.2	18.2	4,579 (269.2)	1,701 (100.0)	2	C	四月上旬	143
南投	埔里	1959	28,900 (104.1)	27,750 (100.0)	2	38.8	22.0	11,234 (184.0)	6,105 (100.0)	1	C	四月上旬	158
	竹山	1960	20,900 (583.6)	3,880 (100.0)	1	34.4	18.6	7,190 (995.0)	722 (100.0)	1	C	三月下旬	151
彰化	二林	1959	9,500 (161.8)	5,870 (100.0)	2	36.5	27.9	5,468 (211.7)	1,638 (100.0)	1	D	四月上旬	166
	花壇	1959	13,700 (126.9)	10,800 (100.0)	1	35.9	21.9	4,918 (207.9)	2,365 (100.0)	1	C	四月上旬	165
	花壇	1960	6,000 (240.0)	2,500 (100.0)	3	37.0	22.0	2,220 (403.0)	550 (100.0)	3	C	三月下旬	151
	秀水	1960	21,000 (147.4)	14,250 (100.0)	2	38.0	23.7	7,980 (236.6)	3,377 (100.0)	1	E	三月下旬	147
雲林	刺桐	1959	10,930 (63.8)	17,130 (100.0)	4						C	四月上旬	152
嘉義	嘉義	1959	13,595 (130.2)	10,440 (100.0)	1	36.6	21.5	4,975 (221.7)	2,224 (100.0)	1	C	三月下旬	151
	竹崎	1959	2,820 (27.6)	10,200 (100.0)	4						C	三月下旬	145
臺南	關廟	1959	2,760 (276.0)	0 (100.0)	1						F	五月上旬	350
屏東	新園	1959	11,500 (109.5)	10,500 (100.0)	2	32.5	25.5	3,738 (139.6)	2,678 (100.0)	2	G	三月中旬	152
	里港	1959	13,600 (109.7)	12,400 (100.0)	1	33.5	26.0	4,556 (141.3)	3,224 (100.0)	1	G	三月下旬	152
	里港	1960	21,890 (110.2)	19,860 (100.0)	1	34.5	28.0	7,552 (135.8)	5,561 (100.0)	1	G	二月下旬	153
	麟洛	1960	23,000 (109.3)	21,050 (100.0)	3	35.0	28.2	8.050 (135.6)	5,936 (100.0)	3	E	二月下旬	152
臺	卑南	1958	15,940 (69.2)	23,020 (100.0)	4	39.0	21.5	6,216 (125,6)	4,949 (100.0)	3	H	三月下旬	116
	卑南	1959	22,200 (233.2)	9,560 (100.0)	2	39.4	18.4	8,786 (510.8)	1,759 (100.0)	1	C	三月中旬	155
	卑南	1960	26,120 (96.5)	27,060 (100.0)	2	39.6	25.8	10,343 (148.1)	6,981 (100.0)	1	H	三月下旬	157

	鹿　野	1958	24,780 (115.0)	21,540 (100.0)	1	40.8	23.2	10,110 (242.3)	4,997 (100.0)	1	C	三月中旬	153
	長　濱	1958	9,880 (316.6)	3,120 (100.0)	2	37.6	35.4	39,140 (336.3)	1,104 (100.0)	1	1	三月中旬	151
	東　河	1958	13,040 (188.9)	6,900 (100.0)	2	37.2	19.2	4,850 (366.1)	1,324 (100.0)	2	I	三月中旬	152
	東　河	1959	18,900 (124.5)	1,518 (100.0)	1	34.8	20.0	6,577 (214.9)	3,036 (100,0)	1	C	三月下旬	165
	東　河	1960	26,280 (150.5)	17.460 (100.0)	2	34.2	29.6	8,987 (173.8)	5,168 (100.0)	1	K	三月中旬	165
	池　上	1958	26,760 (83.5)	32,040 (100.0)	2	39.4	22.6	10,543 (145.6)	7,241 (100.0)	1	C	三月中旬	155
	池　上	1959	24,820 (115,6)	21,470 (100.0)	3	36.8	22.0	9,133 (193.3)	4,723 (100.0)	1	C	三月下旬	160
東	池　上	1960	13,860 (61.9)	22,380 (100.0)	2	35.8	22.0	4,961 (100.7)	4,923 (100.0)	1	C	三月下旬	155
	太麻里	1959	28,920 (126.1)	22,920 (100.0)	3	36.6	21.0	10,584 (219.9)	4,813 (100.0)	2	C	三月下旬	161
	太麻里	1960	23,320 (121.9)	19,120 (100.0)	2	36.2	22.0	8,441 (169.6)	4,206 (100.0)	1	C	三月下旬	156
	吉　安	1959	31,200 (119.0)	26,200 (100.0)	1	28.5	20.0	8,892 (169.6)	5,240 (100.0)	2	C	三月中旬	150
	壽　豐	1959	24,000 (170.2)	14.100 (100.0)	1	28.5	20.0	6,840 (242.5)	2,820 (100.0)	1	C	二月中旬	151
花	壽　豐	1960	21,810 (112.5)	19,380 (100.0)	1	29.5	21.0	7,415 (186.6)	3,973 (100.0)	1	C	三月下旬	143
	新　城	1959	26,800 (113.0)	23,700 (100.0)	1	33.5	20.0	7,772 (163.9)	4,740 (100.0)	1	C	三月中旬	150
	新　城	1960	15,740 (102.9)	15,290 (100.0)	2	28.5	20.5	5,273 (168.9)	3,134 (100.0)	2	C	三月下旬	143
	瑞　穗	1959	20,700 (127.7)	16,200 (100.0)	1	33.5	21.0	5,900 (173.4)	3,402 (100.0)	2	C	三月中旬	151
	瑞　穗	1960	21,690 (105.8)	20,490 (100.0)	1	30.0	21.0	7,266 (168.8)	4,303 (100.0)	1	C	三月下旬	143
蓮	富　里	1959	24,200 (100.0)	24,200 (100.0)	2	35.0	20.0	7,260 (150.0)	4,840 (100.0)	3	C	三月中旬	150
	富　里	1960	21,487 (100.9)	21,270 (100.0)	2	20.0	20.5	7,518 (172.4)	4,360 (100.0)	1	C	三月下旬	143

備註：A＝七十日早，B＝客人種，C＝紅心尾，D＝白和蘭，E＝臺農45號，F＝新31號，G＝恒春種，H＝大有種，I＝臺農17號，J＝白幼藤，K＝臺農13號

五、結論與摘要

1. 冲繩100號係日本冲繩縣立農事試驗場，於1928年以七福爲母本，與潮洲爲父本雜交所育成，1934年命名爲「冲繩100號」。1941年由日本引入我國，1948年經嘉義農業試驗所從南京農業實驗所引入本省。

2. 冲繩100號葉型爲三淺裂，綠色，莖生長匍匐性，莖中下部爲紫色，先端幼嫩部爲綠色，莖上有毛，塊根紡錘形，有縱溝，皮色淡紅，肉色淡黃。

3. 冲繩100號爲早熟品種，耐濕而不耐旱，耐寒性較弱，不宜晚植，對於春作生育期間之高溫多雨氣候，反應不敏感，極適於春季栽培。

4. 雖因各地環境，及氣候等因素影響塊根生產力，但就春季全省區域試驗，或春季試作結果觀察，冲繩100號對於全省適應性極大，在本省三分之二的試驗地區冲繩100塊根產量每公頃爲6.900

—31.000公斤左右，超過在來種約10%—20%左右，全省各地之製簽量則均高於在來種約40%—80%左右。

5. 冲繩100號對於甘藷蔓割病及病縮芽，均具有相當的抗病力。

参考文献

(1) 伊東秀夫(1949) サツマイモの栽培と貯藏。

(2) 王鐵華(1948) 五種甘藷優良品種之介紹。農報十三卷第四期。(384)

(3) 王俠(1951) 甘藷新引進品種特性觀察。

(4) 嘉義農業試驗分所(1954—1956) 試驗研究工作簡報。

(5) 嘉義農業試驗分所(1958) 試驗研究工作簡報。

(6) 嘉義農業試驗分所(1961) 試驗研究工作簡報。

(7) 臺灣省政府農林廳(1959) 全省甘藷新品種試作成績總報告。

AN INTRODUCTION OF THE EXPERIMENTAL RESULTS OF THE SWEET POTATO VARIETY "OKINAWA NO.100"

by

C. K. CHIEN

ENGLISH SUMMARY

1. The sweet potato variety, Okinawa No. 100 was found from the progenies by crossing the Chifu as female parent with Chaochou as male at Okinawa Agricultural Experiment Station in Japan in 1928. It was designated in 1934 and introduced from Japan to China in 1941 and brought to chiayi Agricultrual Experiment Station from Nanking Central Agricultural Experiment Station in 1948.
2. Characteristics of the plant are as follow:
   The leaf is green with tri-cleft incition. The vine is dark purple with the tender part remaining green. The tuber skin is light violet and the flesh is yellow. The root is shortly fusiform in shape with sulcate.
3. Okinawa No. 100 is an early matured and wet tolerant variety, but it is not tolerant to dry condition and cold weather. It is not influeuced by heavy rainfall and high temperature during the spring season. So it is very adapted to spring planting,
4. Although the tuber yields were affected by different climate and soil conditions in various localities, it is widely adapted through this island in accordance with results in both spring regional test and spring planting trial. The yield is from 6,900-31,000 Kilogram per hectare and 10-20% highe than the local varieties at two-third of the experimental plantations in this island, Furthermore, the dry chip yield of this variety is 40-80% higher than the check varieties in all the experimental plantations through the whole island.
5. Okinawa No.100 was considerably resistant to the Fusarium disease and sweet potato scab disease caused by Sphaceloma batatas Sawada.

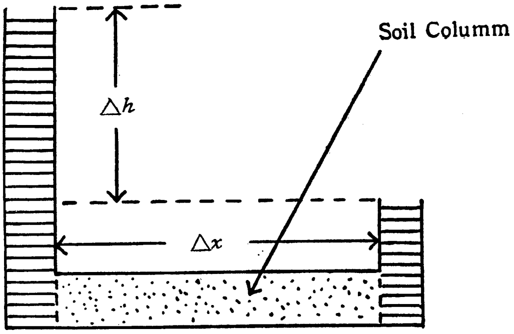
FLOW EQUATION AND ITS APPLICATION TO WATER MOVEMENT IN SOILS

by

L. T. Li

I. EVOLUTION OF FLOW EQUATION

Water always moves from higher potential site to lower potential site. The basic equation describing the relation between the velocity of flow and the potential difference is given by Darcy's law, which is based on the experimental observation. The simplest example leading to Darcy's equation is given in the follwing. In this case, it is one dimensional saturated fiow.



Darcy's equation is given by:

$$\frac{1}{A} \cdot \frac{\Delta Q}{\Delta t} = -K_1 \frac{\Delta h}{\Delta x} \quad \text{or} \quad \frac{1}{A} \cdot \frac{\Delta Q}{\Delta t} = -K_2 \frac{\Delta \phi}{\Delta x}$$

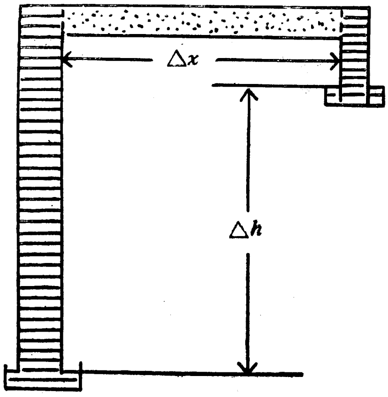
where A is cross sectional area, ΔQ is amount of water which passed the soil column in time Δt, usually measured by volume, Δt is time in second, Δh is difference in hydrolic head, K_1 and K_2 are conductivity, they are constants if soil is uniform. ϕ is potential, in this case $\phi = \rho g h$, Δx is length of soil column, ρ is density of water and g is gravitational acceleration.

In differential form:

$$\frac{1}{A} \cdot \frac{dQ}{dt} = -K_1 \frac{dh}{dx} \quad \text{or} \quad \frac{1}{A} \cdot \frac{dQ}{dt} = -K_2 \frac{d\phi}{dx}$$

The negative sign comes from the fact that if we take x as increasing from left to right, and water flow as positive when it flows from left to right, since $\frac{\Delta h}{\Delta x}$ is always negative when flow is positive, this is a necessary consequence.

In case of unsaturated flow, we may change our experimental set up to the following:



However, there are two states in unsaturated flow. One is steady state, the other is transient state. If sufficient time has elapsed, so that the moisture distribution pattern in the soil column does not change any more, the flow under this condition we call it steady state. In other words, the flow rate is everywhere the same along the soil column. On the other hand, if the moisture distribution pattern is changing, while the flow is taking place, we call it transient state. In other words, the flow rate is no longer constant along soil column.

In case of steady state, Darcy's equation can be writen as follows:

$$\frac{1}{A}\cdot\frac{\Delta Q}{\Delta t}=-\overline{K(\phi)}\frac{\Delta\phi}{\Delta x} \quad \text{where} \quad \overline{K(\phi)}=\frac{\int_{\phi_1}^{\phi_2}Kd\phi}{\phi_2-\phi_1}$$

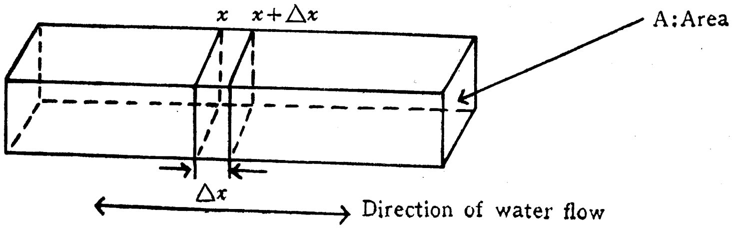
This situation makes the above experimental set up pretty hard to show whether the Darcy's law holds in unsaturated flow or not.

Darcy's equation when applied to unsaturated flow is best written in partial differential equation.

$$\frac{1}{A}\cdot\left(\frac{\partial Q}{\partial t}\right)_x=-K(\phi)\left(\frac{\partial\phi}{\partial x}\right)_t$$

Where $\left(\frac{\partial Q}{\partial t}\right)_t$ is rate of water flow across the cross section at x and is function os time, $\left(\frac{\partial\phi}{\partial x}\right)_t$ is potential gradient at t and is function of x, $K(\phi)$ is conductivity, it shows that K is either function of potential or moisture content, and not a constant as in saturated flow. This equation can be applied in both steady and transient state.

Our next step is to find a partial differential equation which describe the change of moisture distribution pattern with time based on the Darcy's law. For the sake of simpicity, let us consider horizontal flow.



First of all, we have to find the net increase of water in a small volume element $A\triangle x$. If we use the same principle that water flow is positive when it flows to right and x is increasing as it goes to the right, the net increase of water is the difference between the water which passed through the cross section at x and at $x+\triangle x$. In mathematical form:

$$A\triangle x\triangle\theta=\triangle Q_x-\triangle Q_{x+\triangle y}=\left[-AK(\phi)\frac{\partial\phi}{\partial x}\right]_x\triangle t-\left[-AK(\phi)\frac{\partial\phi}{\partial x}\right]\triangle t_{u+\triangle x\theta}$$

where θ is moisture content, and the others as before.

After transposition

$$\frac{\triangle\theta}{\triangle t}=\frac{K(\phi)\frac{\partial\phi}{\partial x}\Big|_{x+\triangle x}-K(\phi)\frac{\partial\phi}{\partial x}\Big|_x}{\triangle x}$$

In limiting case, it becomes:

$$\left(\frac{\partial\theta}{\partial t}\right)_x=\frac{\partial}{\partial x}\left[K(\phi)\frac{\partial\phi}{\partial x}\right]_t$$

If we introduce $\frac{\partial\phi}{\partial x}=\frac{d\phi}{d\theta}\cdot\frac{\partial\theta}{\partial x}$ we can eliminate ϕ so that result is:

$$\left(\frac{\partial\theta}{\partial t}\right)_x=\frac{\partial}{\partial x}\left[D(\theta)\frac{\partial\theta}{\partial x}\right]_t$$

wher $D(\theta)=K(\phi)\frac{d\phi}{d\theta}$, and is called diffusivity which usually considered as function of θ only.

In case of three dimension, it is only a matter of methematical manupulation to show that the net increase in a given volume element $\triangle x\triangle y\triangle z$ is the sum of net increase coming from the flows in X, Y and Z directions. This gives:

$$\left(\frac{\partial\theta}{\partial t}\right)_{x,y,z}=\frac{\partial}{\partial x}\left[K(\phi)\frac{\partial\phi}{\partial x}\right]_{t,y,z}+\frac{\partial}{\partial y}\left[K(\phi)\frac{\partial\phi}{\partial y}\right]_{t,x,z}+\frac{\partial}{\partial x}\left[K(\phi)\frac{\partial\phi}{\partial z}\right]_{t,x,y}$$

Using the vector notation

$$\frac{\partial\theta}{\partial t}=\nabla\cdot(K\nabla\phi)$$

where

$$\nabla=i\frac{\partial}{\partial x}+j\frac{\partial}{\partial y}+k\frac{\partial}{\partial z}$$

This is a general flow equation we are looking for.

II. SOIUTION OF FIOW EQUATION IN SOME SPECIAL CASES

Theoretically, if we can find such function $\theta(x, y, z, t)$ which satisfy the flow equation and also the given boundary and ınitial conditions, our problem is solved. As a matter of fact, the situation is not as simple as I mentioned here. First of all, $D(\theta)$ so defined is not a constant, but rather a complicated function of θ. This makes the differential equation hard to be solved even in its simplest case.

e. g.

$$\frac{\partial\theta}{\partial t}=\frac{\partial}{\partial x}\left(D\frac{\partial\theta}{\partial x}\right)\quad\text{becomes}\quad\frac{\partial\theta}{\partial t}=\frac{dD}{d\theta}\left(\frac{\partial\theta}{\partial x}\right)^2+D\frac{\partial^2\theta}{\partial x^2}$$

is a non-linear form.

Howerver, in the following special cases, some useful knowledge still can be obtained by digging in this equation.

Case 1). Saturated flow.

In this case, K becomes constant and also $\frac{\partial\theta}{\partial t}$ becomes zero. This makes the general flow equation reduces to Laplace equation:

$$\frac{\partial^2\phi}{\partial x^2}+\frac{\partial^2\phi}{\partial y^2}+\frac{\partial^2\phi}{\partial z^2}=0$$

Case 2). Horizontal unsaturated steady state flow.

In this case $\frac{\partial\theta}{\partial t}=0$, so the flow equation becomes:

$$\frac{dD}{d\theta}\left(\frac{d\theta}{dx}\right)^2+D\frac{d^2\theta}{dx^2}=0$$

After integration we get

$$\ln\frac{D}{D_0}=-\int_{\theta_0}^{\theta}\frac{\theta''}{(\theta')^2}d\theta$$

where

$$\theta''=\frac{d^2\theta}{dx^2},\quad \theta'=\frac{d\theta}{dx}$$

D_0 is diffusivity at θ_0

Since θ'' and θ' can be obtained experimentally, this provides one method of evaluating D in unsaturated flow.

Same technique can be used in case of vertical flow, however, the result is more complicated. Conversely, if D is a known function of θ, θ can be obtained as a function of x, since:

$$\frac{d}{dx}\left(D\frac{d\theta}{dx}\right)=0,\quad D\frac{d\theta}{dx}=C_1 \quad \text{and} \quad \int Dd\theta=C_1x+C_2$$

C_1 and C_2 can be evaluated from the given boundary conditions.

Case 3). Horizontal unsaturated flow with the following boundary and initial conditions.

1). Soil column is semi-infintive with uniform initial θ_i at $t=0$.

2). At $t>0$ $\theta=\theta_0$ at $x=0$ and $\theta\to\theta_i$ as $x\to\infty$

This situation is handled by Boltzmann transformation which involves the following theorem.

Given a certain partial differential equation in θ, x and t. If by substitution of $\eta(x, t)$, x and t can be eliminated from the equation, and also the boundary and initial conditions can be described in terms of η only, the solution satisfying the differential equation and also the boundary and initial conditions is function of η only.

Here,

$$\frac{\partial\theta}{\partial t}=\frac{\partial}{\partial x}\left(D\frac{\partial\theta}{\partial x}\right) \tag{1}$$

or

$$\left(\frac{\partial\theta}{\partial\eta}\right)_x\left(\frac{\partial\eta}{\partial t}\right)_x=\left[\frac{\partial}{\partial\eta}\left(D\frac{\partial\theta}{\partial\eta}\cdot\frac{\partial\eta}{\partial x}\right)\frac{\partial\eta}{\partial x}\right]_t \tag{2}$$

where η is function of x and t. If by substitution

$$\eta=xt^{-\frac{1}{2}} \quad \text{or} \quad \left(\frac{\partial\eta}{\partial t}\right)_x=-\frac{1}{2}xt^{-\frac{3}{2}} \quad \text{and} \quad \left(\frac{\partial\eta}{\partial x}\right)_t=t^{-\frac{1}{2}}$$

to (2), equation (1) reduce to

$$-\frac{1}{2}\eta\left(\frac{\partial\theta}{\partial\eta}\right)_x=\left[\frac{\partial}{\partial\eta}\left(D\frac{\partial\theta}{\partial\eta}\right)\right]_t \tag{3}$$

The corresponding boundary and initial conditions are given by

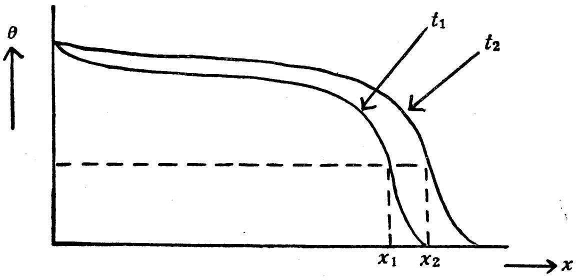
$$\eta\to0 \text{ then } \theta\to\theta_0, \text{ and } \eta\to\infty \text{ then } \theta\to\theta_i$$

where θ_0 is the constant moisture content at $x=0$ after $t>0$, and θ_i is the initial moisture content through out the semi-infinitive soil column at $t=0$. Therefore, (3) can be written as ordinary differential equation.

$$-\frac{1}{2}\eta\frac{d\theta}{d\eta}=\frac{d}{d\eta}\left(D\frac{d\theta}{d\eta}\right)$$

Two important properties result from the above fact.

Property 1). Since θ is function of η only in this case. If one solution is obtained at certain time experimentally, the entire solution is obtained consequently. In other words, from a certain moisture distribution pattern at certain time, we can construct any moisture distrbution pattern at any time.



In the above diagram, two line represent two moisture distribution at t_1 and t_2 respectively. If we draw a hoaizontal line which intersects these two lines at x_1 and x_2, the following equation holds:

$$\frac{x_1}{x_2}=\frac{\sqrt{t_1}}{\sqrt{t_2}}$$

So it is easy to find x_2 if the other three are known.

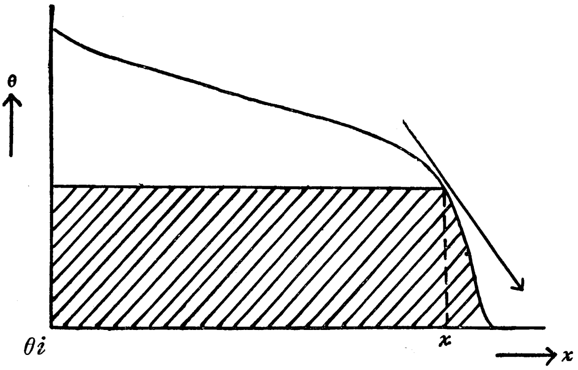
Property 2). From $-\frac{1}{2}\eta\frac{d\theta}{d\eta}=\frac{d}{d\eta}\left(D\frac{d\theta}{d\eta}\right)$ taking t as constant substituting $d\eta=t^{-\frac{1}{2}}dx$ we get:

$$-\frac{1}{2}\frac{x}{t}\cdot\frac{d\theta}{dx}=\frac{d}{dx}\left(D\frac{d\theta}{dx}\right)$$

After integration and transposition we get:

$$D(\theta_x)=-\frac{1}{2t}\left[\frac{dx}{d\theta}\right]_{\theta_x}\cdot\int_{\theta_i}^{\theta_x}x\cdot d\theta \quad \left(\because \left.\frac{d\theta}{dx}\right|_{\theta_i}=0\right)$$

Diagramatically $\int_{\theta_i}^{\theta_x} x \cdot d\theta$ = shaded area $\frac{d\theta}{dx}$ = slope of the tangential line at x.



This provides another way of evaluating D experimentally, and Since this is not a steady state, it is easier to set up experimentally.

Case 4). Vertical unsaturated fiow with the same boundary and intial conditions as in case 3.

In this case, the flow equation becomes:

$$\frac{\partial\theta}{\partial t}=\frac{\partial}{\partial z}\left(D\frac{\partial\theta}{\partial z}\right)+\frac{\partial K}{\partial z}$$

Since Boltzmann transformation never reduce this equation to ordinary differential equation, Philip (3) described another method of changing this equation to ordinary differential equation, and applied it to his "Theory of Infiltration".

Case 5). Vertical unsaturated steady state flow.

In this case the fiow equation becomes:

$$\frac{d}{dz}\left(D\frac{d\theta}{dz}\right)+\frac{dK}{dz}=0 \qquad \left(\because \frac{\partial\theta}{\partial t}=0\right)$$

If D and K are known function of θ, it can be integrated immediately giving:

$$\int\frac{D}{C_1-K}d\theta=z+C_2$$

But it is not easy to find the value of C_1 and C_2 to fit the boundary conditions. Gardner (1) treated this case.

REFERENCE

(1) Gardner, W. R. Some steady state solutions of the unsaturated flow equation with application to evaporation from a water table. Soil. Sci. 85:228, 1958.

(2) Klute, A. Some theoretical aspects of the flow of water in unsaturated soils. Soil Sci. Soc. Am. Pro. 16:144-148, 1952.

(3) Philip, J. R. Thé theory of infiltration: 2. The profile at infinty. Soil Sci. 83:435-448, 1957.

(4) Wylie, C. T. Advance Engineering Mathematics. McGraw-Hill Eook Company, Inc. 206-208.

流動方程式及其在土壤水分移動之應用

李　蘭　帝

摘　　要

本文敍述流動方程式 (Flow Equation) 的誘導及其在土壤水分移動之應用。在本文所舉之例子可解該方程式而知水分移動之情形。

EFFECT OF CHEMICAL ELEMENTS ON THE GROWTH OF CROP PATHOGENS

II. Effect of Hg-, Ni-, Sn-, Pb-, Fe-, and Al-Salts on Rice Blast and Sheath Spot Fungi

by

S. C. Hsu and T. C. Dough

INTRODUCTION

The effects of salts of Cd, Cu, Co, Zn and Mn on the growth of rice blast and sheath spot fungi were investigated in previous report. The present study was conducted to investigate the effects of Hg—, Ni—, Sn—, Pb—, Fe—, and Al—salts on the growth of the same pathogens.

MATERIAL AND METHOD

The salts used in the experiments were shown in Table 1. The isolates of the pathogens were the same as those in the previous experiment. They were renewed on 2% glucose potato agar medium before using for the experiment. Twenty-day culture of the rice blast fungus and 4-day culture of the sheath spot fungus were used throughout the experiment. The composition of media and the concentration of the salts were same as those used in previous experiment.[1] Plate dilution method was employed. Sheath spot fungus grew rapidly and the margins on the colonies were often vague, but the density of the mycelia was influenced distinctly by various treatments. For this reason, in addition to measuring the diameters (size) of colonies, the density of growing mycelia was also observed to evaluate the effects of various treatments when sheath spot fungus was tested. On the contrary, the margins of colonies of rice blast fungus were so clear that their sizes could be measured. So the size of colony was taken as the measure of the effects of various treatments.

Table 1. The Salts used in the experiment

Compounds / Elements	Sulfates	Nitrates	Chlorides	Remarks
Aluminum	$Al_2(SO_4)_3 \cdot 18H_2O$	$Al(NO_3)_3 \cdot 9H_2O$	$AlCl_3 \cdot H_2O$	C. P.
Nickel	$NiSO_4 \cdot 7H_2O$	$Ni(NO_3)_2 \cdot 6H_2O$	$NiCl_2$	C. P.
Tin	$SnSO_4$	—	$SnCl_2 \cdot 2H_2O$	C. P.
Lead	$PbSO_4$	$Pb(NO_3)_2$	$PbCl_2$	C. P.
Iron	$FeSO_4 \cdot 7H_2O$	$Fe(NO_3)_2 \cdot 9H_2O$	$FeCl_2$	C. P.
Mercury	—	—	$HgCl_2$	C. P.

RESULT AND DISCUSSION

1. Effect of various salts on the growth of rice blast fungus.

Table 2 shows the sizes of colonies of rice blast fungus which has been cultured for 12 days on the media containing various salts of different concentrations. As shown in the table, among the salts investigated, $HgCl_2$ has the strongest suppressing effect on the growth of rice blast fungus. This salt still has some suppressing effect at 10^{-4} mol concentration, but does not have remarkable effect at 10^{-5} concentration. Nickel salt ranks second to $HgCl_2$ in regard to suppressing the growth of rice blast fungus. The extension of growing mycelia at 10^{-3} mol concentration was only 1/5 or 1/3 of that of control. But at 10^{-5} mol, Ni-salt did not effect the growth of mycelia. Nickel Chloride was stronger as a poison of the mycelia than its nitrate and sulfate; the sulfate was weakest. The salts of Fe and Pb have a slight suppressing effect on the growth of the fungus. Their chlorides have stronger effects than nitrate and sulfate. Lead nitrate and sulfate do not seem to affect the growth of mycelia.

Neither Al-salt nor Sn-salt showed any influence on the growth of rice blast fungus at the concentrations tested.

From the results shown in Table 2, the orders of suppressing effects of various salts may be as follows:

$$Hg > Ni > Fe > Pb > Al = Zn$$

$$\text{Chloride} > \text{nitrate} > \text{sulfate}$$

Table 2. The effects of some salts on the growth of the rice blast fungus

Concentration / Salts	10^{-3} Mol (cm×cm)	10^{-4} Mol (cm×cm)	10^{-5} Mol (cm×cm)	Remarks
$Al(SO_4)_3 \cdot 18H_2O$	8.0×8.6(1)	8.0×8.0	8.0×8.0	No any effects
$Ni(SO_4) \cdot 7H_2O$	2.3×2.5	7.0×7.0	7.8×7.8	Suppressing effect
$SnSO_4$	8.0×8.0	8.0×8.0	8.0×8.0	No any effects
$PbSO_4$	8.0×8.0	8.0×8.0	8.0×8.0	No any effects
$FeSO_4 \cdot 7H_2O$	7.5×7.5	7.8×7.8	7.9×7.9	Slight suppressing effect
$Al(NO_3)_3 \cdot 9H_2O$	8.0×8.0	8.0×8.0	8.0×8.0	No any effects
$Ni(NO_3)_2 \cdot 6H_2O$	1.7×1.8	6.9×7.0	7.8×8.0	Suppressing effects
$Pb(NO_3)_2$	7.8×8.0	8.0×8.0	8.0×8.0	No any effect
$Fe(NO_3) \cdot 9H_2O$	7.4×7.6	7.8×7.9	8.0×8.0	Slightly suppressing effect
$AlCl_3 \cdot H_2O$	7.8×7.9	8.0×8.0	8.0×8.0	No any effects
$NiCl_2$	1.5×1.5	6.5×6.7	7.5×7.8	Highly suppressing effect
$SnCl_2 \cdot 2H_2O$	8.0×8.0	8.0×8.0	8.0×8.0	No any effects
$FbCl_2$	7.5×7.6	7.6×7.6	8.0×8.0	Slightly suppressing
$FeCl_3$	7.3×7.3	7.5×7.5	7.9×8.0	Slightly suppressing effect
$HgCl_2$	—	6.0×6.0	7.0×7.0	No growth at 10^{-4} Mol
Control	8.0×8.0	Density of all colonies......		

(1) Average of four replications each in two trials.

2. The effects of various salts in the growth of sheath spot fungus.

The influence of various salts on the area and the density of mycelia of sheath spot fungus were presented in Table 3. Since this pathogen grew rapidly, the size of mycelia were observed on the 3rd day after inoculation, but the size was not affected by adding salts. However, the densities of mycelia varied from treatment to treatment, so the density was used as the measures of suppressing effects of the salts.

Table 3. The effects of the various salts on the growth of the sheath spot fungus

Salts \ Concentration	10^{-3} Mol		10^{-4} Mol		10^{-5} Mol		Remarks
	Mycelia (area)	Densi.	Mycelia (area)	Densi.	Mycelia (area)	Densi.	
$Al_2(SO_4)_3 \cdot 18H_2O$	full	+	full	++	full	+++	Suppressing effect at 10^{-3} mol
$NiSO_4 \cdot 7H_2O$	5.5×6.3	+	full	+	full	+	Suppressing effect
$SnSO_4$	full	+++	full	+++	full	++++	No effect
$PbSO_4$	full	+	full	++	full	+++	Slightly suppressing effect at 10^{-3} mol
$FeSO_4 \cdot 7H_2O$	full	++	full	+++	full	+++	No effect
$Al(NO_3)_3 \cdot 9H_2O$	full	++	full	++	full	+++	No effect
$Ni(NO_3)_2 \cdot 6H_2O$	5.2×5.2	+	full	+	full	+	Suppressing effect
$Pb(NO_3)_2$	full	++	full	+++	full	+++	No effect
$Fe(NO_3)_2 \cdot 9H_2O$	full	++	full	+++	full	+++	No effect
$AlCl_3 \cdot H_2O$	full	+	full	++	full	+++	Slightly suppressing effect at 10^{-3} mol
$NiCl_2$	4.8×5.0	+	full	+	full	+++	Suppressing effect at 10^{-3}–10^{-4}
$PbCl_2$	full	+	full	++	full	+++	Suppressing effect at 10^{-3} mol
$FeCl_2$	full	++	full	+++	full	+++	Slightly suppressing effect at 10^{-3} mol
$HgCl_2$	—	—	full	+	full	+	Highly suppressing effect.
Control	full	+++					

(1) Average of four replications each in two trials.

As shown in Table 3, the suppressing effects of various salts on the growth of sheath spot fungus were similar to those on rice blast fungus. Mercuric chloride has the strongest suppressing effect on sheath spot fungus, it inhibits the growth of mycelium completely at 10^{-3} mol concentration; at lower concentrations some growth of mycelium can be observed, but the mycelium is rather scant and lacking in vigor. Nickel salts show inhibiting effects on the area 5 of mycelium as well as on its density regardless of kind of anion.

Aluminum and lead salts have similar effects on the growth of sheath spot fungus. Although the area of mycelium is not influenced by the concentration of the salts, the density is apparently scant at 10^{-3} mol concentration. These salts do not inhibit the growth of sheath spot fungus at 10^{-5} mol concentration. Nitrates

of Al and Pb have weaker effects than sulfates and chlorides. Even at 10^{-3} mol concentration of the nitrates, the growth of mycelium is quite extensive.

Ferrous salts seem to be less poisonous to sheath spot fungus than Al-salts. Only slight suppressing effect on the density of mycelium is found at 10^{-3} mol concentration. Higher concentrations of Fe salts must be required to suppress the growth of this fungus. Stannous salts do not be have as poisons for sheath spot fungus, but they seem to be have as stimutants at low concentration such as 10^{-5} mol.

With a few exception, the effects of various salts on the growth of sheath spot fungus are similar to those for rice blast fungus.

Among the salts investigated, Hg-salt is most poisonous to sheath spot fungus and the suppressing effects on the growth of its mycelium decrease in the following order:

$$Hg > Ni > Al > Pb > Fe > Sn$$

As indicated in Tables 2 and 3, Hg- and Ni-salts have strong suppressing effects on the growth of rice blast and sheath spot fungi. Other salts do not seem to have remarkable on their growth. This result was probably due to their hydrolyses in aqueous solutions. In the solutions there were some sediments, which might be hydroxides. According to Ram[2] who compared the control effects of various salts on tea blister blight, hydroxides are least effective as a fungicide.

The fungicidic effect of Hg-compounds have been well recognized for many years. Chien[3] reported that $HgCl_2$ had some control effect on rice blast fungus when it was applied to soil. In addition to inorganic Hg-salts,[6] organic mercury has been widely used as a fungicide.

The fungicidic effects of Ni-salts have been also observed by Venkata[2] in India. He found that tea blister blight was most effectively controlled by spraying solutions of Ni-salts and that the chloride was most effective, being followed by the nitrate and the sulfats. Although Ni compounds have not been used extensively as fungicides up to present, they are promising for this purpose. Their fungicidic effect must be further investigated.

As shown above, kind of anion may influence the fungicidic effects of salts. This result has been also obtained by Sasaki[4] (Ram) and Mukoo[5]. The fungicidic effects of heavy metall salts seem to derive not only from their cations but also from the anions.

From the results obtained in previous and present experiments, the control effects of various salts on the growth of rice blast fungus decrease in the following order:

$$Cd > Hg > Co > Cu > Ni > Zn > Fe > Pb > Al > Sn > Mn$$

For sheath spot fungus, the order may be as follows.

$$Cd > Hg > Co > Ni > Cu > Zn > Al > Pb > Fe > Sn > Mn$$

SUMMARY

The effects of some inorganic saltes on the growth of rice blast and sheath spot

fungi were investigated. Among the salts tested, $HgCl_2$ shows the strongest fungicidic effect. Nickel salts also has inhibitory effects on both fungi, but the effect decreases rapidly as the concentration is decreased.

Ferrous- and lead-salts at 10^{-3} mol concentration inhibit slightly the growth of rice blast fungus, while Al- and Sn-salts show little effect. Aluminum- and lead-salts seem to affect the density of mycelium of sheath spot fungus, but Fe-and Sn-salts show no effect.

In both [previous and [present experiments, chlorides are most effective for inhibiting the growth of both fungi.

Fungicidal effects of the salts so far tested on rice blast fungus decreases in the following order:

$$Cd>Hg>Co>Cu>Ni>Zn>Fe>Pb>Al>Sn>Mn$$

The order for sheath spot fungus is as Follows:

$$Cd>Hg>Co>Ni>Cu>Zn>Al>Pb>Fe>Sn>Mn$$

LITERATURE CITED

(1) Hsu, S. C. and Dough, T. C. Effect of chemical elements on the growth of crop pathogens. 1. Effect of Cd, Co, Cu, Zn and Mn on the fungi of rice blast and sheath spot diseases. Jaurnal of Taiwan Agri. Research 10(4):47-52, 1961.

(2) Ram, C. S. Venkata. Action of Nickel salts on the blister blight fungus in situ. Phytopathology 53:276-278. 1963.

(3) Chien, C. C. The effect of the Mercury Chloride in occurrence of blast disease of rice seedling. (Unpublished) 1962.

(4) Sasaki, Shigeki. Fungicidal effect of Cadomium compound (1). Annals of the Phytopathological Society of Japan. 27:87. 1962.

(5) Mukoo, K. Studies on the causal bacteria of the loquat canker (1). Bulletin of the National Institute of Agricultural Sciences, Series C. No. 1. pp. 1-184., 1952.

(6) Tasugi, H. Effects of various elements on the resistance of rice blast disease. Agr. and Hort. 31(1):151-154 1956.

化學元素對作物病原菌之影響

第二報 Hg, Ni, Sn, Pb, Fe, Al 等元素對稻熱病及稻紋枯病菌發育之影響

徐 水 泉　　杜 自 彊

摘　　要

爲明瞭各種化學元素對作物病原菌發育之影響如何，而擧辦本試驗。所得結果，希望可供爲農藥資源開發及植病防治上之參考資料。

在本試驗之第一報，曾使用 Cd, Co, Cu, Zn ，及 Mn 等五種重金屬元素爲材料並已報告(1)，故本試驗仍依照第一報之設計及方法，繼續檢討 Hg, Ni, Sn, Pb, Fe，及 Al 等元素對稻熱病菌及稻紋枯病菌發育之影響。玆將所得之結果摘錄如下：

(1) 本試驗使用之六種元素中，氯化汞對稻熱病菌及稻紋枯病菌發育之抑制力最強。

(2) Ni 化合物在 10^{-3} Mol 濃度時，能抑制稻熱病菌及稻紋枯病菌之發育。

(3) Pb 及 Fe 兩元素在 10^{-3} Mol 濃度時稻熱病菌菌絲之發育稍有影響，但 Al 及 Sn 在 10^{-3} Mol 濃度時仍無任何影響。

(4) Al 及 Pb 在 10^{-3} Mol 濃度時對稻紋枯病菌菌絲發育密度有抑制現象。但 Fe 與 Sn 對菌絲密度之影響並不顯著。

(5) 本試驗採用之三種鹽類中，以氯化物之抑制力最大。此與第一報之結果相同。

(6) 本試驗使用之六種元素，對稻熱病菌之發育抑制力之順序是 Hg>Ni>Fe>Pb>Al>Sn，而對稻紋枯病菌之順序則是 Hg>Ni>Al>Pb>Fe>Sn，兩者因病原菌之不同略有差異。

稻熱病菌對水銀離子耐性之研究*

簡　錦　忠

一、前　　言

近年來本省對於稻熱病之研究工作已逐漸加強，並獲悉省內之稻熱病菌有10餘種不同生理型之存在[1]。又在田間應用有機汞劑類之殺菌劑對該病已得優良之防治效果。但多年連續施用水銀劑之影響，將來可能出現變異性之耐藥菌系。關於此項研究，據 J. J. Christensen[2] 之報告，*Gibberella zeae* 在含有 malachite green, ethyl mercuric phosphate，等培養基上繼代培養時，該菌對此等藥劑漸呈抵抗性，又山崎氏[5]等對稻熱病菌與硫酸銅，硼酸亦有同樣之報告。且吉井氏[8,9,10] 等曾提出稻熱病菌對 phenyl mercuric acetate 之耐性報告。本研究係爲探討本省稻熱病菌對汞劑耐性產生與否而作此試驗。

本研究進行時，得鍾順昌先生之協助，文成蒙臺灣大學陳教授其昌校閱，均此一併謹誌謝忱。

二、試驗材料與方法

I　供試材料：

(1)　供試病菌：稻熱病菌 (*Piricularia oryzae* Cav.) 係本系保存，致病力強之 0S-45S 菌號（對16種判別稻種均呈感病性病斑）及致病力弱之 1C-32S 菌號（僅對16判別稻種中之崑山五香粳及臺中65號兩品種呈感病性病斑）。

(2)　供試水銀離子：$HgCl_2$

(3)　基礎培養基：馬鈴薯煎汁洋菜培養基 (P. S. A.)。

II　方　　法：

將基礎培養基（馬鈴薯 200 g, 洋菜 18 g, 蒸餾水 1000 cc, 蔗糖 20 g），加注不同濃度之 $HgCl_2$（最低濃度自 0.018 mM 開始，分爲五階段，每階段增加 0.025～0.032 mM 之濃度），然後倒入培養瓶內（每瓶 20 cc.），待凝固後，接種稻熱病菌之小菌絲塊，並放置於 28°C 定溫箱內，經過一定時間後觀察各處理之菌落色澤，形態及生長速度等性質，二週後作最後之觀察。測定該菌在水銀離子下之可能生長濃度，同時另以無加水銀離子之馬鈴薯培養基爲對照，並比較兩生理型之病菌對水銀離子耐性之差異。

根據上述測定之結果，判定其可能生長之最高濃度之菌落爲次代之接種源，並以此濃度爲最低濃度，分爲五階段與對照比較，如此連續進行測定試驗，至最高耐性濃度之確定爲止。以探討 *P. oryzae* 在不同濃度之水銀離子上連續培養及獲得耐性之程度。再將耐性菌及正常菌於溫室內舉行接種試驗。根據本研究室鑑定稻熱病菌生理小種之方法，於16判別稻種上，測定其感病反應之差異。

三、結 果 及 討 論

A　兩種不同生理小種之稻熱病菌對水銀離子之自然抵抗性：

未曾與藥劑接觸過之病原菌，對於該藥劑本來就具有之抵抗性，稱之爲自然抵抗性。而一般由田間採集之病原菌，直接測定其對藥劑可能生長之界限濃度爲自然抵抗性，實際上因田間藥劑防治之結果，田間直接採得之菌種，其對藥劑之抵抗性可能已受藥劑之影響。本試驗所供試之菌系，係

*本研究之完成得國家長期發展科學委員會之補助。

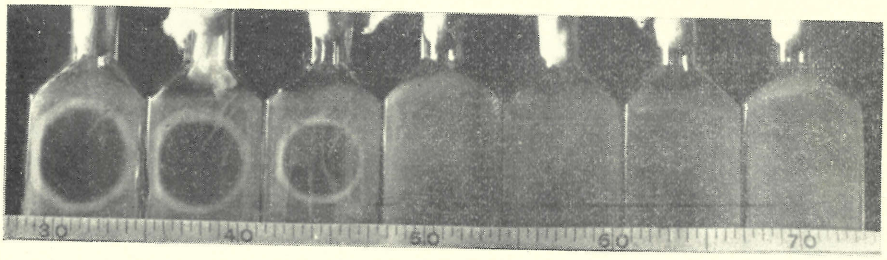
本系稻熱病菌生理小種研究室，由全省各地直接採集，經單胞純系分離及連續培養保存者。如表一，致病力強之生理小種 (0S～45S) 其自然 抵抗 性爲 0.05 mM (圖一) ; 致病力 弱之 生理 小種 (1C–32S) 爲 0.082mM (圖一) 。

表一 不同濃度之水銀離子對稻熱病菌兩菌絲生長之影響

Table 1. The natural resistance of two different physiologic races of *P. oryzae* against mercuric chloride

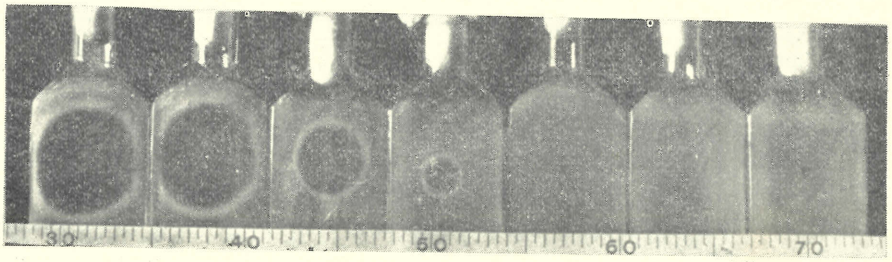
菌株 \ 菌落直徑 (mm) \ $HgCl_2$ 濃度 (mM)	0.018	0.050	0.082	0.114	0.146	0.178	CK
0S–45S	44	36	—	—	—	—	48
1C–32S	56	30	16	—	—	—	56

註：接種後第10天之調查記錄。



CK 0.018 0.050 0.082 0.114 0.146 0.178 mM

0S–45S



CK 0.018 0.050 0.082 0.114 0.146 0.178 mM

1C–32S

圖一 不同濃度之水銀離子對稻熱病菌兩菌絲生長之影響

Figure 1. The natural resistance of two different physiologic races of *P. oryzae* against mercuric chloride

B 兩種不同生理小種之稻熱病菌對水銀離子耐性之增強：

爲測定稻熱病菌在田間是否對水銀離子具有耐性之增強，事先在實驗室內檢討其耐性增強之可能性是必然的。本試驗以 P. S. A. 爲基本培養基 ， 注入數種不同濃度之昇汞，以測定自然抵抗性所得 0.050 mM 之致病力強菌絲及 0.082 mM 之致病力弱菌絲爲接種源。經培養測定後，以其最高濃度生長之菌絲爲次一系列水銀離子培養基之接種源，每兩週爲一代連續培養結果如表二。兩種生理小種顯示不規則之耐性增強，漸次由 0.050 或 0.082 mM 達 0.375 mM 。

如表二，數代連續培養試驗之結果，稻熱病菌對水銀離子，顯示不規則之耐性增強，每一代之增強由 0.025 mM 至 0.100 mM 不等。耐性之增加每代逐漸減少 ，第六代達 0.375 mM 後， 兩生理小種都達最高耐性，連續再培養四代其耐性即不增加，亦無減低之趨勢，乃保持於 0.375 mM

表二　兩種不同生理小種之稻熱病菌對水銀離子耐性增強之情形

Table 2. Increasing drug resistance of two different physiologic races of *P. oryzae* against mercuric chloride.

代數	菌株 \ 菌落直徑 (mm) \ $HgCl_2$ 濃度 (mM)	0.034	0.050	0.066	0.082	0.093	0.114	0.125	0.150	0.175	0.200
1	0S-45S	40	32	26	22	16	⑧	—	—	—	—
2							40	36	32	26	16
3											24
4											
5											
6											
7											
8											
9											
10											
1	1C-32S			36	24	18	⑫	—	—	—	—
2						42	32	24	18	12	⑥
3											12
4											
5											
6											
7											
8											
9											
10											

代數	菌株 \ 菌落直徑 (mm) \ $HgCl_2$ 濃度 (mM)	0.225	0.250	0.275	0.300	0.325	0.350	0.375	0.400	CK_x	CK
1	0S-45S	—								48	48
2		④	—	—	—	—				56	56
3		6	②	—	—	—	—	—		60	60
4			66	62	(52)	—	—	—	—	66	68
5					10	④	—	—	—	62	70
6						20	12	⑧	—	68	72
7								⑧	—	60	60
8								⑩	—	62	66
9								⑥	—	62	66
10								⑧	—	60	62
1	1C-32S	—	—							54	54
2		—	—	—	—	—				56	56
3		10	6	②	—	—	—	—		56	56
4				66	(60)	—	—	—		66	68
5					10	④	—	—	—	66	70
6						20	16	⑫	—	64	68
7								⑩	—	60	60
8								⑩	—	60	60
9								⑩	—	64	66
10								⑩	—	66	66

註：1. CK：示正常菌之對照處理。

2. CK_x：示耐藥菌之對照處理。

3. ○：示下代之接種源。

之濃度上。各處理之菌落色澤，形態均與未經藥劑處理之對照相同，只是生長速度每代均有變化，此因受藥劑濃度之抑制外，天然培養基養分之差異亦有密切關係。

C　兩種不同生理小種之稻熱病菌對水銀離子耐性之持續：

水銀離子耐性菌於基礎培養基（無藥劑）上作復元培養試驗，以觀察耐性持續之有無。山崎等曾將硫酸銅耐性之稻熱病菌以無硫酸銅培養基作數代之復元培養，其耐性稍爲降落，但不能復元。本試驗第一代 (0.114 mM) 耐性菌在無水銀離子之基礎培養基上，以二週爲一代，連續測定其耐性之程度。經10代之結果如表三。

表三　第一代 (0.114 mM) 耐性菌與其每代復元菌在不同濃度之水銀離子培養基之發育比較

Table 3. The mycelial growth of 0.114 mM resistant culture and each of its recovered stage.

菌株	$HgCl_2$ 濃度 (mM)	0.05	0.10	0.150	0.200	0.250	CK_x	CK
0S–45S	0.114 mM 耐藥菌	+++	++	+	+	−	+++	+++
	復元菌代數 Stage of recovered culture 1	+++	++	+	+	−	+++	+++
	2	+++	++	+	+	−	+++	+++
	3	+++	++	+	+	−	+++	+++
	4	+++	++	+	+	−	+++	+++
	5	+++	++	+	+	−	+++	+++
	6	+++	++	+	+	−	+++	+++
	7	+++	++	+	+	−	+++	+++
	8	+++	++	+	+	−	+++	+++
	9	+++	++	+	+	−	+++	+++
	10	+++	++	+	+	−	+++	+++
1C–32S	0.114 mM 耐藥菌	+++	++	+	+	−	+++	+++
	復元菌代數 Stage of recovered culture 1	+++	++	+	+	−	+++	+++
	2	+++	++	+	+	−	+++	+++
	3	+++	++	+	+	−	+++	+++
	4	+++	++	+	+	−	+++	+++
	5	+++	++	+	+	−	+++	+++
	6	+++	++	+	+	−	+++	+++
	7	+++	++	+	+	−	+++	+++
	8	+++	++	+	+	−	+++	+++
	9	+++	++	+	+	−	+++	+++
	10	+++	++	+	+	−	+++	+++

註：1. 復元菌供於第一次耐性測定者來自 0.114 mM 耐藥菌在無水銀離子之基礎培養基上（CK_x）生長者，第二次者來自第一次 CK_x，第三次者來自第二次 CK_x，以下類推。
2. ＋：示發育良；　±：示發育不良；　－：示無生長。
3. 接種後第十天之調查記錄。

據表三顯示稻熱病菌，經連續復元培養其對水銀離子之耐性均無變化。在此試驗範圍內爲永續性，其機構如何，值得更進一步之研究。

D　耐藥菌與正常菌之病原性比較：

利用本研究室研究稻熱病病原菌生理小種之設備，判別稻品種及方法，測定耐藥菌及正常菌在

16判別稻品種上之感病反應，並與未經處理母菌比較其病原性之差異。其結果如表四。

表四 未處理之母菌與處理後之耐藥菌及正常菌對16判別稻品種上之感病反應

Table 4. Comparing the disease reactions of 16 different rice varieties to the drug resistant cultures with to normal 10-stages cultures and to morther culture.

菌株 / 稻品種	0S-45S			1C-32S			備考
	母菌	耐藥菌	正常菌	母菌	耐藥菌	正常菌	
崑山五香粳	S	S	S	S	S	S	
臺中 65 號	S	S	S	S	S	R	
稗稈稻	S	S	R	R	R	R	
臺中 171 號	S	S	R	R	S	R	
嘉農 242 號	S	S	S	R	S	S	
光復 1 號	S	S	S	R	S	S	
嘉農育280號	S	S	R	R	S	R	
臺中系比33號	S	S	R	R	S	R	
關東 51 號	R	R	R	R	R	R	
農林 21 號	R	R	R	R	R	R	
Sensho	R	R	R	R	R	R	
Cutsugulcule	S	S	S	R	R	R	
Natala	S	S	S	R	S	S	
高脚柳州	S	S	S	R	R	R	
高雄大粒清油	S	S	S	R	R	R	
臺中低脚烏尖	S	S	S	R	R	R	

據表四得知，經10代連續培養之正常菌與$HgCl_2$不同濃度之培養基連續培養所得耐藥菌，其病原性似有顯著變化。據本試驗結果，致病力強及弱之兩菌株，耐藥菌之病原性都強於正常菌。一般病原菌經培養基上連續培養後，其病原性均有退化現象，但經藥劑處理之耐藥菌，都無此現象。如表四，致病力強之菌號 (0S-45S)，耐藥菌在16稻品種上之感病反應與母菌完全相同，而經連續培養10代之正常菌且有退化情形發現。致病力弱之菌株 (1C-32S)，耐藥菌之致病力強於對照處理之正常菌，但母菌之致病力反而差於處理後之菌種，此原因可能受試驗環境之差異所致或病原菌本身之變異現象，有更進一步探討之必要。

四、摘　　要

本試驗係於實驗室內探討兩種不同生理小種之稻熱病病原菌，由於連續施用水銀劑後是否可能產生變異性耐藥菌種而舉行，其結果簡述如下：

1. 致病力強之稻熱病菌生理小種，對 $HgCl_2$ 之自然抵抗性為 0.050mM ，致病力弱之生理小種為 0.082mM。

2. 供試兩生理小種對水銀離子顯示不規則之耐性增強。培養至第六代達 0.375mM 為最高耐性。此後再連續培養四代，均未有增加耐性之趨勢。

3. 供試耐藥菌 (0.114 mM) 之兩種生理小種，連續培養於無藥劑之基本培養基內，其對水銀離子耐性之增加一致保持在 0.20 mM，似可認本菌對水銀離子具有永續耐性。

4. 根據處理前與處理後之菌種接種於16種稻品種上所呈現病斑之差異，測定其病原性之結果

，耐藥菌之病原性均强於連續培養後之正常菌，與處理前母菌之病原性比較，致病力强之生理小種耐藥菌與母菌完全相同，連續培養之正常菌且有退化現象。致病力弱之生理小種耐藥菌及正常菌均比母菌爲强。

參 考 文 獻

(1) Chien, C. C., S. Y. Lin and S. C. Jong (1963): Studies on the physiologic races of *Piricularia oryzae* Cav. (II) Agricultural Research 12 (3) : 29-39.

(2) Christensen, J. J. (1946): Genetic Variation in *Gibberella zeae* in Relation to Adaptation, Phytopathology 36: 396.

(3) 井上親男，佐々木茂樹(1957)：**2**、**3** 水稲病害菌に對する水銀の作用(講要)日、植、病、報，22：38.

(4) 鈴木穗積 (1962) ：いもち菌の薬劑耐性 (講要) ，日、植、病、報，27 (**2**) ：85.

(5) 山崎義人，土屋茂 (1956) ：植物病原菌の薬劑抵抗性，植物防疫，10 (**5**) ：187～190.

(6) 山崎義人 (1961) ：いもち病菌の薬劑抵抗性，植物防疫，15 (**5**) ：220～224.

(7) Yamasaki, Y. (1954): Drug-resistance of the rice blast fungus, *Piricularia oryzae*, Br. et Cav. Proc. Intern. Gen. Symp., 448～452.

(8) 吉井啓，淺田泰次，木曾皓 (1956) ：植物病原菌の薬劑耐性に關する研究，(II)フエニール醋酸水銀に對する稻熱病菌の耐性について (講要) ，日、植、病、報，21：131.

(9) 吉井啓、淺田泰次、木曾皓、田邊昇 (1957) ：植物病原菌の薬劑耐性に關する研究(III)フエニール酢酸水銀耐性，稻熱病菌の他水銀劑による影響並びにその耐性の持續について (講要) ，日、植、病、報，22：33.

(10) 吉井啓、淺田泰次、木曾皓、田邊昇 (1958) ：植物病原菌の薬劑耐性に關する研究，第一報フエニール酢酸水銀に對する稻熱病菌の耐性について，日、植、病、報，23：215～218.

STUDIES ON THE DRUG RESISTANCE OF *PIRICULARIA ORYZAE* AGAINST MERCURIC CHLORIDE

by

C. C. Chien

ENGLISH SUMMARY

In order to determine the drug resistance of *Piricularia oryzae*, the rice blast fungus, against mercuric chloride ($HgCl_2$), two different physiologic races of *P. oryzae* were tested in this experiment. The results are summarized as follows:

(1) The natural drug resistance of 0S–45S, a strongly virulent race is at 0.05 mM; while 1C–32S, a weakly virulent race, at 0.082 mM.

(2) When the two different races of *P. oryzae* was cultured on the potato dextrose agar medium containing different concentrations of $HgCl_2$ for 6 stages (one stage is formed of 2 weeks culture). The fungus acquired the highest degree of drug resistance at 0.375 mM.

(3) Even if the drug resistant fungus at 0.114 mM is cultured on the normal medium containing no mercuric chloride for 10 stages (one stage is formed of 2 weeks culture), its resistance is not lost.

(4) Comparing the disease reactions of 16 differential rice varieties to the drug resistant cultures with to normal 10–stage cultures (successive cultivation on normal medium containing no mercuric chloride) of these two different races, the drug resistant cultures of both races are stronger in infectivity than normal 10–stage cultures of them. While compared with mother cultures, the drug resistant culture of 0S–45S race showed the same virulence as its mother culture, but the normal 10–stage culture became weaker in virulence. However, the drug resistant culture and normal 10–stage culture of 1C–32S race were more virulent than their mother culture.

UTILIZATIONS OF THE SFECIAL CANKER LESION ON SUNKI LEAVES

by

T. C. YANG

INTRODUCTION

Citrus canker caused by *Xanthomonas citri* (Hasse) Dowson is normally characterized by corky, hard, and somewhat suberized lesions surrounded by a yellowish halo on the infected leaves of susceptible varieties. If the canker lesion has developed quickly under extremely favorable conditions, the white spongy tissue will excruded in some degree, and accumulated on the lesions. This special canker lesions with spongy eruption of tissue will be found, sometime, when artificial inoculation was made by overstaying the inoculated plant in pot (Fig. 4) in the inoculation chamber for three or four days after inoculation. It is also easy to induce special lesions by keeping the leaves of susceptible varieties in such a semi-vivo condition as in the moistened Petri-dish (Fig. 3) placed in the incubator for five or six days after inoculation.

The present author was deeply interested in the formation of this special lesion and had made his attempt to utilize them for several purposes, such as screen test for canker-control bactericides, identrfication of newly isolated canker organism, and determination of resistance of citrus varieties to the disease. The present report was made in deal with utilization of this inoculation technique for testing inhibiting effectiveness of the bactericides on the fomation of canker lesion.

MATERIALS AND METHODS

Two pieces of roof-shaped plastics with two cuts on their ridge were placed on the filter paper in the Petri-dish, 12 cm in diameter. Two glass rods were then fitted on the cuts of the plastic supporters to form a bridge-like frame (Fig. 1). Enough water for wetting the filter paper was poured into the Petri-dish.

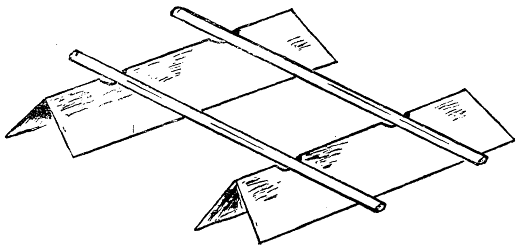


Fig. 1. Bridge-like frame in moistened Petri-dish.

* The author wish to acknowledge his indebtedness to Dr. H. J. Su of National Taiwan University for his valuable suggestions and criticisms during preparation of this paper.

Leaves of Sunki (*Citrus sunki*) seedling grown in the experimental farm of the Taiwan Agricultural Research Institute were detached from the base of the petiole with a scissors and were throughly washed by gentle soaking in the running tap water followed by drying with filter paper.

Definite number of wounds were carefully made by puncturing the leaves on two or three layers of filter paper with dissecting needle. Bacterial suspension was prepared in 100 ml conical flask by dissolving the colony of bacteria cultured on the nutrient agar slant at 28°C for 48 hrs with sterile distilled water.

The Sunki leaves mentioned above were dipped individually in the bacterial suspension for certain minutes and then were placed on the glass frame in the Petri-dish. Keep the Petri-dish in the incubator for six days before reading. The percentage of the lesion developed was calculated by direct counting of the number of lesions.

LESION DEVELOPMENT

In order to clarify the relation between the maturity of the leaves and the development of the special lesion, the leaves were divided into four grades of maturity as young, premature, mature and old, according to their size and color. Premature leaves were fully expanded but still yellowish green in color, and mature leaves were dark in color. The lesion most easily developed on these leaves according to the resultant data. Young, not fully extend, and old leaves, nearby falling, however, easily either corrupted or dried out during the experiment (Fig. 6).

As for the temperature in relation to the development of the lesion, 28°C was most favorable for the lesion development, although 22°C, 25°C, 31°C and 34°C were also favorable as suggested by the resultant data. Horever, no lesion developed at 16°C. The leaves frequently dried out at 37°C, although a few lesions were found at this temperature.

The size of the wound is important to the development of the lesions, for most of them were formed more distinctly on the wound on which no necrotic were examined. Accordingly, it is necessary to pay the special carefulness and use a fine needle during the puncturing in order to make a nice wound.

SCREEN TEST OF THE FUNGICIDES FOR THE DISEASE CONTROL

The chemicals and their active ingredients used in this experiment are shown in Table 1.

The stock solution of each fungicide was prepared saparately with sterile distilled water in 125 ml conical flask. Dilution was made by transferring each stock solution in the flask with a pippet into 100 ml beaker and enough dose of sterile water was added up to a given concentration. The leaves punctured, fourty wounds a leaf, were inoculated by soaking them in the bacterial suspension in 1000 ml beaker for 5 minutes followed by dipping in the fungicide solution for 10

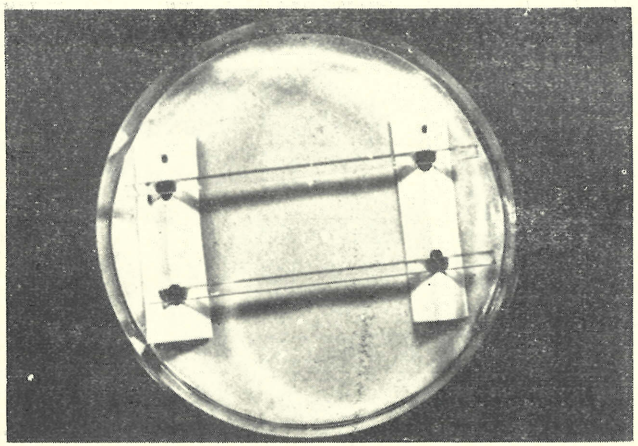


Fig. 3. Moistened Petri-dish for the special canker lesion formation.

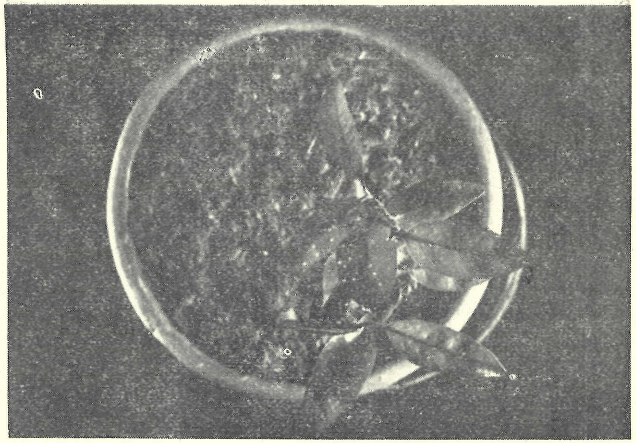


Fig. 4. The special lesions on the leaves of inoculated Sunki seedling in pot.

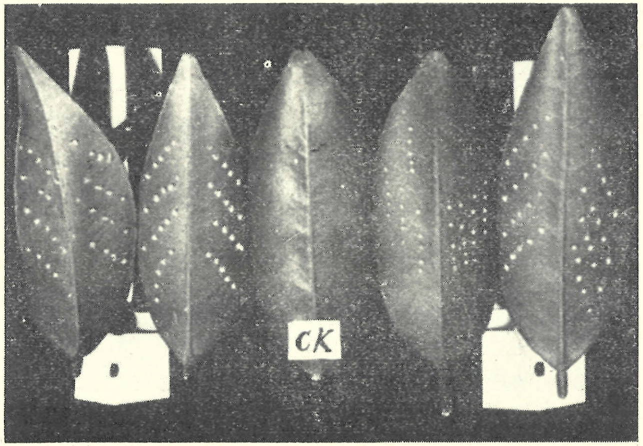
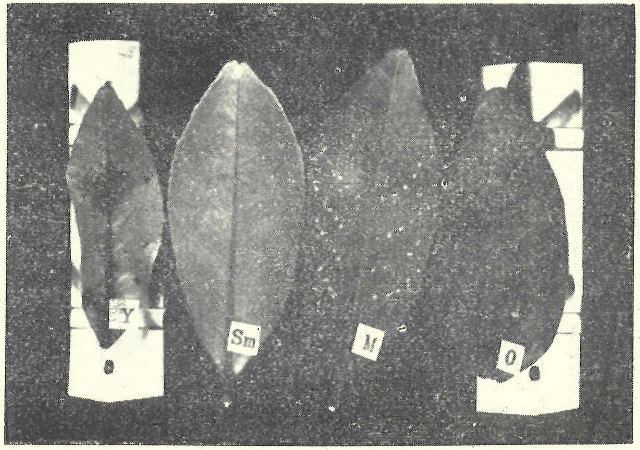


Fig. 5. The special canker lesions formed on detached leaves of *Citrus sunki*.



Fig, 6. Showing the special canker lesions formed on Sunpi leaves of different maturities.

Table 1. Chemicals and their active ingredients used

Chemicals	Active ingredients	Manufecturer
Agrimycin-100	Streptomycin, 15% Terramycin 1.5%	Pfizer Inc., U. S. A.
"Ortho" streptomycin	Streptomycin sulfate 21.2%	Califonia Spray- Chemical Corp., U. S. A.
"Takeda" mycin	Dihydrostreptomycin 2.5%	Takeda K. K., Japan
"Nichinou" phytomycin	Streptomycin 4.5%	Nihon Nohyaku K. K., Japan
"Sankyo" phytomycin	Streptomycin 4.5%	Sankyo K. K., Japan

minutes. The dropdews on the leaves were dried with filter paper. Each four leaves were placed in the Petri-dish and incubated.

Incubation at 28°C was ended six days after inoculation. The resultant dada are shown in Table 2. The regression lines were calculated and plotted on the graph paper (Fig. 2).

Table 2. Inhibitory effect of the chemicals on the development of canker lesions on Sunki leaves

Conc.	Agrimycin-100		Ortho Streptomycin		Takedamycin		Sankyo Phytomycin		Nichinou Phytomycin		CK	
(ppm)	I.*	D.**	I.	D.	I.	D.	I.	D.	I.	D.	I.	D.
12.5	7.0	93.0	5.5	94.5	7.5	92.5	2.5	97.5	10.0	90.0	0.0	100
	11.5	88.5	9.0	91.0	0.0	100.0	7.5	92.5	14.0	86.6	0.0	100
	5.0	95.0	0.0	100.0	15.5	84.5	0.0	100.0	0.0	100.0	0.0	100
25	17.5	82.5	7.0	93.0	0.0	100.0	6.5	93.5	24.0	76.0		
	28.5	71.5	23.0	77.0	41.5	58.5	10.0	90.0	8.5	91.5		
	19.5	80.5	0.0	100.0	10.5	89.5	0.5	99.5	0.5	99.5		
50	15.5	84.5	26.5	73.5	5.0	95.0	12.0	88.0	11.5	88.5		
	32.5	67.5	6.0	94.0	39.5	60.5	35.5	64.5	40.0	60.0		
	37.0	63.0	13.5	86.5	15.0	85.0	28.5	71.5	1.5	98.5		
100	77.5	22.5	0.0	100.0	20.0	79.5	5.5	94.5	6.5	93.5		
	59.5	40.5	40.0	60.0	36.5	63.5	29.5	70.5	53.0	47.0		
	25.0	75.0	36.0	64.0	12.5	87.5	58.0	42.0	3.5	96.5		
200	80.0	20.0	47.5	52.5	25.0	75.0	25.0	75.0	40.0	60.0		
	63.5	36.5	13.5	86.5	37.5	63.0	27.5	72.5	59.0	41.0		
	38.5	61.5	57.5	42.5	30.5	69.5	55.5	44.5	19.5	80.5		

* Percentage of lesion inhibited
** Percentage of lesion developed

Culculation of regression line:

1. Agrimycin-100:

$$byx=\frac{n\sum xy-\sum x\sum y}{n\sum x^2-(\sum x)^2}=\frac{15(58781.25)-(1162.5)(518)}{15(159843.75)-(1162.5)^2}=0.27$$

$\sum y=na+byx\cdot\sum x$ $\quad a=13.61$ $\quad y=13.61+0.27x$

$$\text{Correlation coefficient } (r)=\frac{\sum(x-\bar{x})(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2\cdot\sum(y-\bar{y})^2}}=\frac{18636.25}{24446.56}=0.76$$

$$F\text{ value}=\frac{r^2\sum(y-\bar{y})^2/1}{(1-r)^2\sum(y-\bar{y})^2/n-2}=\frac{r^2(n-2)}{1-r^2}=\frac{7.5088}{0.4224}=17.78$$

$17.78>F_{0.05}=4.67$

2. "Ortho" streptomycin:
   $byx=0.18$ $a=5.05$ $y=5.05+0.18x$
   $r=0.68$ $F=11.18>F_{0.05}=4.67$
3. "Takeda" mycin:
   $byx=0.10$ $a=12.02$ $y=12.02+0.1x$
   $r=0.49$ $F=4.11<F_{0.05}=4.67$
4. "Sankyo" phytomycin:
   $byx=0.17$ $a=7.09$ $y=7.09+0.17x$
   $r=0.67$ $F=10.59>_{0.05}=4.67$
5. "Nichinou" phytomycin:
   $byx=0.16$ $a=7.03$ $y=7.03+0.16x$
   $r=0.58$ $F=6.58>F_{0.05}=4.67$

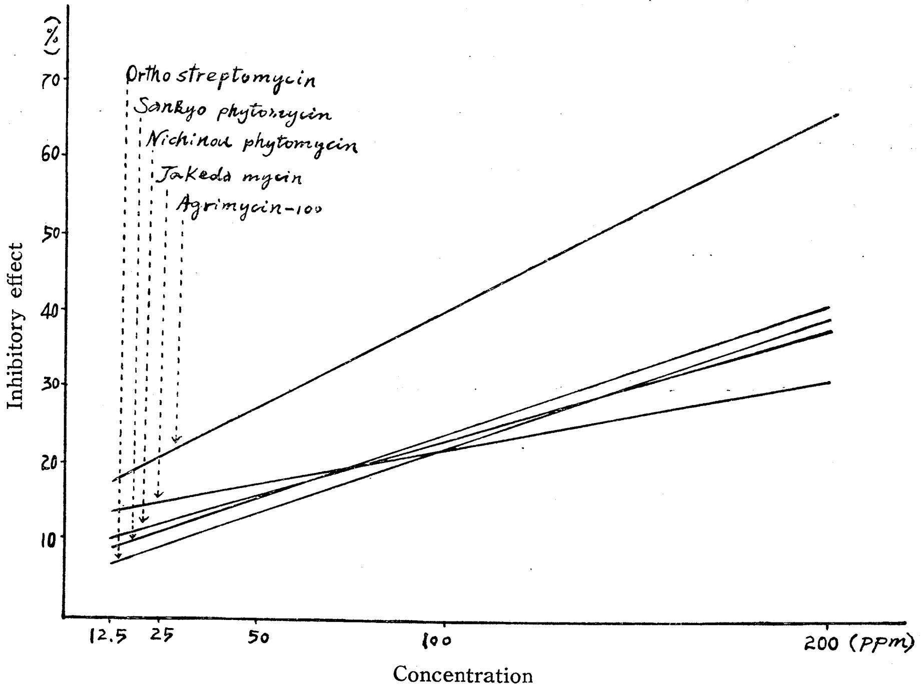


Fig. 2. DR curves of different bactericides at various concentrations.

DISCUSSION AND CONCLUSION

Like other pathogenic bacteria, the canker bacterium, *Xanthomonas citri* is killed in vivo by bactericides at higher concentration than in vitro. Some troubles were frequently borthering the investegators in their screen tests on bactericiides for disease control because of the different results obtained in laboratory and field test.

It was experienced that the distinctive special canker lesion was easily formed on Sunki leaves by artificial inoculation under extremely favorable conditions. The author has tried to employ this inoculation technique for screen test of the canker-control bactericides in his laboratory. It is easy to obtain Sunki leaves since the citrus variety has been widely used as root-stock on this Island. The present method designed by the author seems to be easily conduted and just the

simple facilities are necessary during the experiment. Moreover, it takes brief in time for carying out the experiment.

The significant regression line showing the correlation between the formation of the special lesions and inhibition by some test bactericides at various concentrations was obtained as shown in the resultant data mentioned above. It is recognized by the author that this methed might be a convenient and recomendable way for preliminary experimant for screen test with bactericides for canker control.

LITERATURE

(1) Arny, D. C. (1952) The bioassay of Ceresan M on treated oat kernels. Phytopathology 42: 222-223.

(2) Hasse, Clara H. (1915) Pseudomonas citri, the cause of Citrus canker. Jour. Agri. Res. 4:87-100.

(3) Jong S. C. and C. C. Chien. (1963) Screening test of effective fungicides against *Pellicularia sasakii* with the Kozaka's broadbean method. Plant protection bulletin 5(3):351-361.

(4) Keil, H, L., J. G. Horsfall, and S. Rich. (1952) Relation of laboratory ED50 to field performance of fungicides. Phytopathology 42:113.

(5) Miller, H. J. (1943) A comparison of laboratory and field retention and protective value of certain copper fungicides. Phytopathology 33:899-909.

酸桔葉片殊形潰瘍病斑之利用

楊　騰　金

摘　要

柑桔類潰瘍病於極度適宜之環境下所發生之病斑，因罹病組織之海棉細胞受病原菌之刺激致呈畸形膨大，多量溢出，而形成白色隆起之明顯殊形病斑，此種殊形病斑頗易由人工接種而顯現。將酸桔半成熟葉片採下，以自來水冲洗後以解剖針輕刺一定數目之傷痍，浸漬於病原菌懸浮液，使葉面餘液陰乾後排放於潮濕培養皿之玻璃支架上，置 28°C 定溫箱培養六天，即可於傷痍部位呈現明顯之殊形潰瘍病斑。

筆者以此病斑形成之明顯與容易，乃探測其利用價值。本試驗以五種抗生製劑供作傷痍葉片人工接種後作藥劑浸漬處理，以葉片病斑發生數目，測定供試藥劑對病原菌之抑制或殺滅效力。據試驗結果，病斑之發生與藥劑濃度具有規律之相關關係。筆者認爲此法於藥劑試驗之初步選定上，爲一簡便而可行之方法。

西瓜蔓割病病原菌之研究

胡 開 仁　　宋 細 福　　游 健 治

一、前　　言

西瓜味美可口，爲吾人所共嗜之。由於本省氣候，土壤均甚適宜西瓜之生長，且在栽培上頗富經濟價值，故成爲本省重要經濟作物之一。

惟據近年之調查(10)西瓜蔓割病已嚴重爲害本省各地，甚者毫無收穫，全功盡棄，時有所見，此蔓割病病原菌 *Fusarium oxysporum* f. *niverum* (E. F. smith) Snyder et Hansen. 是否還有不同生理型之存在，其生理性質與不同寄主之感病性如何？對此尙缺乏系統之研究與探討，筆者有鑑於此，乃從事西瓜蔓割病病原菌之研究，玆將研究結果報告如下。

二、材 料 及 方 法

㈠材料：

1. 病原菌的來源：

481 菌號：臺北本所農場，新大和品種，幼苗生長至寸許，發生萎縮，基部縊小，倒伏枯死。前期作物甘薯，48年 7 月10日分離。

482 菌號：臺中龍井鄉，蜜寶品種，蔓莖長約 1 公尺時，全株枯萎，剖切根冠及根，發現維管束部份變黃色，48年 5 月分離。

483 菌號：臺中龍井鄉，蜜寶品種，植株長約 1 公尺，蔓莖節間變褐色，其上散生黑色小點，並顯有粘液，頂端葉芽萎縮，48年 5 月分離。

484 菌號：臺南安南區，品種不詳，蔓莖長約70公分，全株枯萎，剖切根及根冠，維管束部份均變黃色，48年 6 月分離。

485 菌號：雲林，幼苗萎縮枯死，48年 6 月分離。

486 菌號：雲林，幼苗萎縮枯死，48年 6 月分離。

487 菌號：臺南仁德鄉，幼苗生長至寸許，基部現縊小，萎縮倒伏，49年 2 月22日分離。

488 菌號：屏東佳冬鄉，幼苗生長至寸許，萎縮枯死，49年 3 月24日分離。

489 菌號：臺北本所農場，植株生長約60公分，部份蔓莖萎縮枯死，49年 8 月分離。

㈡試驗方法：

1. 胞子測定試驗：

供試各病原菌接種於馬鈴薯培養基上，置於 28°C 定溫培養，定時鏡檢各菌號，胞子大小，隔膜，厚膜胞子數。

2. 生理試驗：

將供試九個菌號分別接種於馬鈴薯培養基上，分別置於不同溫度 (25°, 30°, 35°, 40°C) 與調節不同 pH 值 (pH 2. 4. 6. 8. 10) 馬鈴薯培養基，培養一週後，調查其菌絲發育情形。

3. 病原菌與不同寄主之感病性反應試驗：

將分離所得西瓜蔓割病菌三個菌號 (481，483，485) ，接種於11種作物之幼苗，觀察其發病率。

三、試驗成績

(一) 胞子測定試驗：

1. 本試驗供試九個菌號病原菌均使用馬鈴薯培養基（配合量，馬鈴薯 200g.，洋菜 20g.，蔗糖 20g，蒸溜水1000c.c.）置於 28°C 定溫箱培養，每個菌號每週鏡檢100個胞子，測量其大小，隔膜數，厚膜胞子數，每個菌號各測四週，結果如表一及表二。

表一　西瓜蔓割病病原菌胞子調査記錄表

菌號	培養週數	分生胞子 平均値（μ）	分生胞子 大小（μ）	胞子長度（%） 1−10μ	11-20μ	21-50μ	隔膜數（%） 0	1	2	3	4	厚膜胞子 厚膜胞子（%）	厚膜胞子 平均値（μ）	厚膜胞子 大小（μ）
481	1	3.5× 8.2	2.6—3.5×6.5—16.25	93	7	0	98	2	0	0	0	0	0	
	2	3.3× 8.7	2.6—32.5×4.9—26	90	9	1	74	22	3	1	0	0	0	
	3	3.2× 9.3	1.6—4.9×5.9—17.9	75	25	0	68	31	1	0	0	3	7.5×8.5	6.5—9.8×6.5—10.4
	4	2.4× 9.5	3.3—3.9×5.9—16.3	75	25	0	38	62	0	0	0	0	0	
482	1	3.4× 8.5	2.6—3.3×4.9—17.4	87	13	0	99	1	0	0	0	0	0	
	2	3.3× 8.7	2.6×3.3×4.9—13	85	15	0	99	1	0	0	0	0	0	
	3	3.1× 9.2	2.6—3.3×6.5—17.9	82	18	0	98	2	0	0	0	0	0	
	4	3.6×10.8	2.6—3.9×3.9—26	60	36	14	97	3	0	0	0	0	0	
483	1	3.8×12.6	2.6—6.5×5.2—32.5	54	35	11	100	0	0	0	0	0	0	
	2	3.8×14.6	2.6—3.9×8.1—39	37	48	15	96	0	1	3	0	0	0	
	3	3.8×15.0	2.6—6.5×6.5—45.6	39	47	14	80	16	1	2	1	4	8.12×8.45	6.5—11×8.1—11.4
	4	4.2×17.9	3.3—5.2×6.5—45.6	39	21	40	61	5	9	20	5	21	6.5×7.2	4.9—×6.5—9.8
484	1	3.7× 9.7	3.3—4.9×5.9—13.0	84	16	0	100	0	0	0	0	0	0	
	2	3.5× 9.7	1.6—3.9×4.9—16.3	71	29	0	99	1	0	0	0	0	0	
	3	3.6×10.2	3.3—4.9×4.9—22.9	68	31	1	95	4	1	0	0	4	5.9×8.5	4.9—6.5×6.8—9.8
	4	3.2× 8.8	2.0—3.3×3.3—14.6	81	19	0	97	3	0	0	0	1	6.5×8.1	6.5×8.1
485	1	5.5×17.8	3.3—6.5×6.5×32.5	18	48	34	97	3	0	0	0	0	0	
	2	5.7×25.8	3.3—6.5×3.0—35.8	4	28	68	61	11	13	15	0	0	0	
	3	5.9×25.5	3.9—6.5×3.0—39.0	3	35	62	72	6	16	6	0	0	0	
	4	5.5×26.1	3.9—6.5×9.8—39.0	6	28	66	57	14	14	15	0	1	9.7×9.7	9.7×9.7
486	1	3.9× 9.8	2.6—4.9×6.5—16.3	72	28	0	100	0	0	0	0	0	0	
	2	3.6×11.1	2.6—6.5×4.9—35.0	56	42	2	88	9	2	1	0	0	0	
	3	3.7×11.3	2.6—6.5×6.5—32.5	48	51	1	88	9	1	2	0	4	6.5×10.4	4.9—9.8×6.5—13
	4	3.4×10.9	2.6—4.9×6.5—14.6	47	53	0	87	13	0	0	0	0	0	
487	1	3.3× 7.9	2.6—3.3×5.9—13.0	94	6	0	100	0	0	0	0	0	0	
	2	3.8×10.2	6.5—6.5×8.1—14.6	69	31	0	100	0	0	0	0	0	0	
	3	2.9× 9.9	2.9—3.9×6.5—14.7	64	36	0	100	0	0	0	0	5	9.4×11	6.5—12.4×9.8—13
	4	3.4× 9.3	2.6—3.3×4.9—19.5	79	21	0	99	1	0	0	0	17	8.8×9.1	8.1—10.4×7.2—10.4

488	1	3.4× 8.7	2.6—4.9×4.9—14.6	88	12	0	100	0	0	0	0	0	0	
	2	3.5× 9.6	2.6—3.9×6.5—12.4	79	21	0	100	0	0	0	0	0	0	
	3	3.3×10	2.9—3.3×6.5—13.7	70	30	0	100	0	0	0	0	1	6.5×11.4	6.5×11.4
	4	3.3× 8.7	2.9—3.0×6.5—13.0	90	10	0	100	0	0	0	0	12	8.8×9.1	5.9—9.8× 8.1—9.8
489	1	3.2× 8.0	2.6—3.9×6.5—36.0	92	7	1	100	0	0	0	0	0	0	
	2	3.6× 9.7	2.6—6.9×3.9—22.8	83	15	2	94	5	1	0	0	0	0	
	3	3.8× 9.0	2.7—4.2×6.5—29.3	62	32	6	90	6	3	1	0	23	8.5×10.7	3.9—1.3× 8.1—19.5
	4	3.4×10	2.6—4.9×3.9—22.8	69	30	1	73	23	2	2	0	8	6.5×7.5	6.5—8.1× 6.5—9.8

表二　西瓜蔓割病病原菌胞子比較表

菌號	分生胞子			厚膜胞子			
	平均值 (μ)	大小 (μ)	隔膜數	有無	形成週數	平均值 (μ)	大小 (μ)
481	3.1×8.9	1.6—3.5×5.9—26	3	有	3	7.5×8.5	6.5—6.5×9.8—10.4
482	3.35×9.3	2.6—3.9×3.9—26	1	無	—	～	
483	3.9×15.03	2.6—5.2×6.5—45.6	4	有	3	7.30×7.8	4.9—6.5×11—11.4
484	3.5×9.6	1.6—4.9×4.9—22.9	3	有	3	6.2×8.3	4.9—6.8×6.5—9.8
485	5.65×24	3.3—6.5×6.5—39	3	有	4	9.7×9.7	9.7×9.7
486	3.65×10.78	2.6—4.9×6.5—35.8	3	有	3	6.5×10.4	4.9—6.5×9.8—13.0
487	3.35×9.33	2.6—4.9×3.3—19.5	1	有	3	9.1×10.0	6.5—9.8×12.4—13.0
488	3.38×9.25	2.6—4.9×4.9—14.6	無	有	3	7.6×10.2	5.9—8.1×9.8—9.8
489	3.5×9.18	2.6—3.9×4.9—29.3	3	有	3	7.5×9.25	3.9—8.1×1.3—19.5

(1)供試九個菌號中以485菌號胞子較大，平均長度在 20μ 以上，屬大型胞子，483 菌號次之，平均長度在 15μ 以上，屬中型胞子，其他各菌號之胞子平均都在 11μ 以下，屬小型胞子。

(2)九個菌號在培養鏡檢第一週調查時97%以上均爲無隔膜之小胞子，極少形成有隔膜的大胞子，一般在第二週後漸次形成有隔膜之大胞子，惟488菌號均不形成隔膜。

(3)九個菌號中只有482菌號不形成厚膜胞子外，其他各菌號均在培養第三週形成厚膜胞子。

（二）不同溫度與西瓜蔓割病病原菌之生長比較：

本試驗供試之病原菌接種原均使用馬鈴薯培養基，於 28°C 定溫培養一週後，分別接種於同樣馬鈴薯培養基上 (10 c.c.) 扁平培養在 25°，30°，35°，40°C，四種不同溫度下，每個菌號重複三次，一週後調查其發育情形，平均結果如下表：

表三　溫度與病原菌生育情形之比較

菌號	菌落	溫度			
		25°C m.m.	30°C m.m.	35°C m.m.	40°C m.m.
481	直徑	70.5	66	17.5	0
	色澤	紫	深紫	深紫	
482	直徑	87	76	23	0
	色澤	淡紫	白	白	

483	直徑	67	50.1	21	0
	色澤	白	白	白	
484	直徑	60	49.5	22	0
	色澤	白中心之外圍紫	白，中心之外圍紫	白，中心之外圍紫	
485	直徑	71.5	81	67	0
	色澤	白	白	白	
486	直徑	71.5	63	23	0
	色澤	白中心紫	白	白	
487	直徑	81	78	39	0
	色澤	中心邊均爲白中間紫	中心邊均爲白中間紫	中心邊均爲白中間紫	
488	直徑	85	67.5	25	0
	色澤	紫色氣生絲多	紫色氣生絲多	紫色氣生絲多	
489	直徑	77	69.2	26	0
	色澤	深紫	深紫	深紫	

由上表得知各供試菌號在 25°C 下，生長均爲良好而485菌號在 30°C 下生長最優，35°C 下亦較其他各菌號生長爲佳，其他菌號在 35°C 下生長均甚緩慢，在 40°C 下各菌號均不能生長。

又觀察各菌落之色澤，481，488，489，各菌號均呈紫色至深紫色，483，485 菌號均呈白色，482，486，菌號在 30°，35°C 下均呈白色。在 25°C 下，482 菌號呈淡紫色，486 菌號中心呈紫色，其他亦呈白色。484，487兩菌號在上述各種溫度下，中心與邊均呈白色，中心外圍一圈呈紫色。

(三) 不同 pH 值之培養基，培養西瓜蔓割病病原菌之生長比較：

本試驗亦使用馬鈴薯培養基，調整 pH 值爲 2，4，6，8，10 等五級，每級每個菌號重複三次，放在 25°C 定溫箱扁平培養一週後，調查發育情形如下表：

菌號	菌落	pH 值 2 (m.m.)	4 (m.m.)	6 (m.m.)	8 (m.m.)	10 (m.m.)
481	直徑	0	39	73.5	80	71.5
	色澤		紅紫	紫	白，中心紫	白，中心紫
482	直徑	0	40	70	65	62
	色澤		紫	白	白	白
483	直徑	0	33	57	61	59.5
	色澤		白，中心紫	淡紫	淡紫	白，中心紫
484	直徑	0	33.5	49.5	50	50
	色澤		白	白	白	白
485	直徑	0	44.5	62.5	61.5	56.5
	色澤		白，氣生絲多	白，氣生絲多	白，氣生絲多	白，氣生絲多

486	直徑	0	32	68.5	74	72
	色澤		紫	淡紫	淡紫	淡紫
487	直徑	0	48.5	59.5	57	43.5
	色澤		紫	白	白	白
488	直徑	0	41.5	73.5	74	73
	色澤		紫	淡紫	淡紫	淡紫
489	直徑	0	40.3	78.5	83	60
	色澤		紅紫	白	白	白

由上表得知一般菌號在 pH 6～8 時生長最佳，pH 10 時生長較慢，pH 4 時均生長不良，pH 2 時培養基呈液狀，培養一週後均不見其生長，惟484菌號在 pH 8 與 10 時生育無差異，均甚良好。

又觀察各菌號之色澤，大部份在 pH 較低時色澤呈現較濃，pH 較高時色澤亦隨之漸淡。

（四）西瓜蔓割病病原菌與不同寄主之感病性試驗：

本試驗採用大型胞子 485 菌號，中型胞子 483 菌號及小型胞子 481 菌號作爲試驗材料，將上述各菌號接種於稻桿培養基上（稻草切成 3～4cm 長，放入 2％之蔗糖水中煮沸至稻桿變暗褐色時撈出，裝入三角瓶殺菌），置於 28°C 定溫箱培養，經 5 天後，接種於無菌狀態培育之各種寄主幼苗莖部及根部（用三角瓶置適量之濕砂，經 120°C 殺菌後，播下消毒過的寄主種子，待其發芽），接種時室溫爲 28°C，其結果如下表：

表五　不同菌號西瓜蔓割病病原菌與不同寄主之感病性比較

寄主名稱	菌號	接種株數	發病株數	罹病率(％)
大和西瓜	481	20	20	100
	483	20	20	100
	485	20	20	100
蜜寶西瓜	481	20	20	100
	483	20	20	100
	485	20	20	100
進生西瓜	481	20	20	100
	483	20	20	100
	485	20	20	100
越瓜	481	20	20	100
	483	20	20	100
	485	20	20	100
南瓜	481	20	13	65
	483	20	20	100
	485	20	20	100

苦瓜	481	20	0	0
	483	20	12	60
	485	20	12	60
胡瓜	481	20	20	100
	483	20	20	100
	485	20	20	100
香瓜	481	20	20	100
	483	20	20	100
	485	20	20	100
花生	481	20	0	0
	483	20	0	0
	485	20	0	0
絲瓜	481	20	0	0
	483	20	20	100
	485	20	20	100
冬瓜	481	20	10	50
	483	20	20	100
	485	20	20	100

由上表觀知瓜類植物接種此三個菌號，罹病率除 481 菌號在南瓜上達 65 %，冬瓜上 50 %，苦瓜完全不感染，483菌號在苦瓜能感染60%，及485菌號在苦瓜上亦能感染60%外其他皆能達到100%之發病率，但接種於花生幼苗時均不能感染。

四、討論與結論

西瓜蔓割病病原菌胞子之形狀大小，以往已有很多的報告，一般都認爲有大小二種胞子，大型胞子呈星月形，小型胞子呈橢圓形或紡錘形。福士與田中兩氏 (1925) 報告，本菌胞子大小在 3.5—6×21—57μ，出田氏 (1926) 指出本菌分生胞子有 1—5 個隔膜，普通 3 個隔膜大 3.5—5 × 13—40μ，100個胞子平均值4.3—29.91μ，中田氏 (1934) 指出，本菌大型胞子 1—3 個隔膜，3—4.9×32—42μ，小型胞子單胞大 3,2—4×6—10μ，Stevens (1950) 指出本菌分生胞子有 3 個隔膜大 3—4.25×30—50μ，普通具有 4—5 個隔膜，Walker (1952) 指出，本菌多產生單胞胞子，小胞子 2.5—4×6—15μ，大胞子較少，有 2—3 個隔膜，大3.5—5.5×25—33μ，在培養基上較古老之菌絲中可形成厚膜胞子。

本試驗供試九個菌號中，每菌號以 400 個胞子平均值，大致可分爲小型胞子，平均 3.5×10μ 左右，中型胞子平均 3.9×15μ 左右，大型胞子 5.6×24μ 三組，上述出田氏 (1926) 所指之胞子平均值，及大型胞子之大小，及普通的隔膜與本試驗之 485 菌號很近似。

又上述各氏所指最大胞子長度均在 33—57μ 之間，但在本試驗表二所示最大胞子長是 14.6—45.6μ，Walker 氏 (1952) 所指小胞子最小爲 2.5×6μ，本試驗最小胞子484菌號爲 1.6×4.9μ。胞子隔膜數除488菌號不形成外；其他各菌號均隨培養週數而增加，最多隔膜爲483菌號之胞子有 4 個隔膜，無隔膜之小胞子佔數最多，厚膜胞子除 482 菌號不形成外，其他各菌號於培養三週後均有形成。

溫度對病原菌之發育具有決定性之影響，溫度不適則病原菌卽無法成長爲害，中田氏（1934）及河合氏（1958）報告均認爲菌絲發育最適溫度爲 24—27°C，最高溫度 38°C，最低溫度 4°C，Walker 氏（1952）指出土溫在 20°—30°C 時本菌爲害西瓜幼苗甚激，33°C 以上則該菌停止發育，人工培養以 27°C 生長最適。

本試驗九個菌號中除 485 菌號在 30°C 時生長最好外，其他菌號均在 25°C 生長最好，40°C 時均不能生長，與上述各氏報告相符合。

關於西瓜蔓割病病原菌在不同 pH 值下之生長，中田氏（1934）報告，本菌生長範圍自 pH 2.3—9，最適反應爲 4.5—5.8，田中氏（1951）亦指出本菌以 pH 4.5—5.8 發育最適，河合氏（1958）指出本菌生長範圍以 pH 2.4—9.1，最適爲 pH 5.6—6.2。

本試驗九個菌號自 pH 4—10 均能發育，pH 2 時均不發育，pH 4 時生長不良，且所呈色澤較深，pH 10 時一般生長較緩慢，除484菌號在 pH 8—10 生長相同外，其他均在 pH 6—8 之間生長良好，與上述各氏所示生長 pH 範圍相接近。

關於西瓜蔓割病之寄主植物，出田氏（1926）報告，分離本菌用人工接種於西瓜，經 1—3 週均能致病，其他瓜類及其他作物均不發病，河合氏（1958）指出，本菌人工接種於西瓜及香瓜均能致病，其他絲瓜，黃瓜均不致病。

根據培養及顯微鏡觀測選出大、中、小，三型胞子，接種於11種作物上，所獲結果，西瓜、越瓜、香瓜、胡瓜，均有100%的發病率，絲瓜481菌號（小型胞子）與河合氏（1958）所指者相同不感病，惟483菌號（中形胞子）485菌號（大型胞子）均有60%的罹病率，花生均無發病。

由此觀之，本試驗三個菌號中，小型胞子較大型胞子致病力爲弱。

摘　　要

本試驗分離西瓜蔓割病病原菌計有 481，482，483，484，485，486，487，488，489，等九個菌號。依胞子平均值之大小分爲大（5.65×24μ），中（3.9×15μ），小（3.65×10.79μ）三組，大胞子較小胞子對寄主植物之致病力爲強。

除485菌號在 30°C 時生長良好外，其他八個菌號均在 25°C 時生長良好，在 40°C 時均不能生長。各菌號在 pH 4—10 均能生長，除484菌號在 pH 8 與 10 時亦能生長良好外，其他各菌號均在 pH 6—8 生長較佳。全部各菌號在 pH 4 與 pH 10 生長均較緩慢，pH 2 時均不能生長。

參 改 文 獻

(1) Wollenweber H. W.: Studies on the Fusarium Problem Phytopathology 3: p24-50. 1913.
(2) 出田新一：日本植物病理學下卷 p1038-1041. 1926.
(3) 臺灣總督府中央研究所：臺灣產菌類調查報告等四編 p115. 1928.
(4) 中田覺吾郎：作物圖篇 p508-509. 1934.
(5) Snyder W. C. and Hansen H. N.: The species concept in Fusarium American journal of botany Vol. 27 p64-67. 1940.
(6) Stevens F. L.: Plant disease Fnngi p428. 1950.
(7) 田中彰一：蔬菜病害防除論 p99-102. 1951.
(8) Walker J. C.: Diseases of Vegetable Crops p190-197. 1952.
(9) 河合一郎：園藝病害編 p107-110. 1958.
(10) 黃讃，簡和順，西瓜重要病害調查，臺灣省農業試驗所農業研究 Vol. 9 No. 3 p32-39. 1960.
(11) Barnett H. L. Illustrated genera of Imperpect Fnngi p68-69.

SOME PHYSIOLOGICAL STUDIES ON *FUSARIUM OXYSPORUM* F. *NIVERUM* (E. F. S.) S. et H., THE CAUSAL AGENT OF *FUSARIUM* WILT OF WATERMELON

by

K. Z. Hu, S. F. Son, & C. C. Yu

Summary

Nine cultural isolates of *Fusarium oxysporum* f. *niverum* (E. F. S.) S. et H. were obtained. They were designed at Nos. 481, 482, 483, 484, 485, 486, 487, 488, and 489. According to the average of conidia size, three kinds of conidia were obtained. The macroconidia are the size of $5.64\times 24\mu$ and the microconidia, the size of $3.69\times 10.78\mu$. Between macroconidia and microconidia are the size of $3.9\times 15.03\mu$. The macroconidia is more pathogenic than the microconidia.

The growth and development of No. 485 were normal at 30°C. on the other hand Nos. 481, 482, 483, 484, 486, 487, 488, and 489 grew normally at 25°C. All isolates did not grow at 40°C.

As to the range of pH value, they even could grow normally at the range of pH 4 to 10. No. 484 grew normally at pH 8 to 10. The others had the optimum at pH 6 to 8. They grew slower at pH 4 or 10 than at pH 6 to 8. At pH 2, all isolates could not grow.

幾種主要蔬菜害蟲藥劑防治田間試驗

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蔬菜多為短期而直接銷售之農作物。農民為提高其所植蔬菜之品級，就必須施用藥劑，以保護其產品使絕對不受害蟲之為害。惟蔬菜害蟲之種類複雜，且多不易防除；加以菜價波動，菜農之收益不能獲得保障，故菜農必須在各方面設法減低其耕作成本。因此有些菜農在蔬菜上乃使用價廉、效強，但有損於人體健康之高毒性農藥。除此之外，由於蔬菜上已連續多年施佈農藥，乃至增加昆蟲之抵抗力，故既或使用高毒性農藥亦必須提高其使用濃度及用量，否則亦難奏效，故農藥遺毒問題乃漸趨嚴重，而構成目前之一重大社會問題。

解決蔬菜上「農藥遺毒」之辦法，除需加強教育並有效監督農民施用農藥之外，最澈底辦法是設法選擇效強價廉而對人畜之毒性較低之農藥以取代高毒性農藥，此即本試驗之目的。此項試驗工作係為研究幾種農藥在田間之治蟲效果及其受環境因素之干擾。本試驗之所試農藥有 DDVP, sevin, sumithion, thioden及zectran五種，該等農藥係經室內選汰試驗自多種農藥中所選出者。其供試作物包括韭菜、豇豆、及包心白菜等三種。分別在臺北縣三重市，蘆洲鄉及臺北市之双園區舉行。茲將其試驗方法及所得結果報告如後：

一、材料及試驗方法

本試驗所測之殺蟲藥劑有 50% DDVP 乳劑 (Nogos 50 E, Ciba 製品)，85% sevin 可濕性粉劑 (Union Carbide 製品)，50% sumithion 乳劑 (0, 0-dimethyl-0-[3-methyl-4-nitrophenyl] phosphorothioate, 住友公司製品)，35% thiodan 乳劑 (6, 7, 8, 9, 10, 10-hexachloro-1, 5, 5a, 6, 9, 9a-hexahydro-6, 9-methano-2, 4, 3-benzodioxathiepine-3-oxide, Hoechst 製品) 及 23% zectran 乳劑 (4-dimethylamino-3, 5-xylyl methylcarbamate, Dow 製品) 等五種。該等農藥均係自室內試驗所選出治蟲效力效佳者。本試驗各藥之供試濃度均以有效成份計算，除 sevin 為 0.1%及 0.05%外，其餘均用 0.05 %及 0.025%。其用量則因供試農作物而不同，但均比照一般使用標準，經分別記錄於以下各節。各試驗區內均設農民習慣用藥方法一組以為參照，其用為對照組之農藥為 parathion, malathion 及 diazinon 等三種，茲將其試驗結果納入於第一表之對照組內。

本試驗共包括三種供試蔬菜，分別在三個地區進行（區間結果不作比較），各區所佔試驗地面積以 0.1 公頃為原則。茲將各區試驗之進行情形，分述如下：

I. 韭菜：本試驗之研究對象為葱薊馬 (*Thrips tabaci* Lindeman)。其試驗地設於臺北縣三重市五谷廟，農民李念里韭菜田中。

本試驗為 11處理，一組對照，各 2 重複，計 24 小區。小區面積為 36.9 平方公尺（區畔不計在內），總試驗田面積為 999 平方公尺。自52年 4 月25日開始第一次噴藥，其後每隔10天噴藥一次，共計噴藥四次，施藥濃度見第一表所列。稀釋液用量為每小區 4.42公升。於每次噴藥前調查害蟲密度，至 6 月10日調查總被害狀，檢查其被害葉，計其被害率%，列於第一表內。按韭菜被薊馬為害後，其葉面發生白色斑點。輕者減低其經濟價值，稍重者則至無法出售。本試驗以被害葉有15個以上之斑點為被害標準，此種被害情形已達無法出售程度。故本試驗所調查之被害百分率實已相當被害損失之百分率。

註 1.臺北農業改良場技正　2.農業試驗所技正　3.農業試驗所技術員。

Ⅱ. 豇豆：本試驗之研究對象爲綠椿象 (*Nezara vividula* Linnaeus)。此蟲殊難防治，目前農民多施用 parathion 防止此蟲之爲害，惟豇豆爲陸續採收之農作物，故目前施藥方法極應予以改善。試驗田設於豇豆產地臺北市双園區，農民林火樹田中。本試驗爲12處理，一組對照，各2重複，計26小區。小區面積爲28.6平方公尺，連同區畔總試驗田面積爲853.9平方公尺。自52年5月7日第一次施藥後，每隔10天施藥一次，共用藥五次。其中前三次稀釋液用量爲每小區2公升；後二次爲每小區3公升。

最後一次施藥後5日調查各處理供試荳莢之被害數，計其百分率。其取樣方法係在試驗區各行中，每隔5株取樣一株，如此每區共取樣25株。計算各供試株之被害莢數。豆莢被椿象爲害後，初現退色，繼而發生黃白色乃至褐色斑點，並現畸型，斑點逐漸擴大而硬化乃至破裂。被害豆莢，自變爲畸型開始即已無法銷售。本試驗係以畸型豆莢爲檢定被害率之標準。故本試驗所調查之被害率，實已相當於經濟損失之百分率。

Ⅲ. 包心白菜：本試驗之研究對象爲小菜蛾 (*plutella maculipennis* Curtis) 及夜盜蟲(*Prodenia litura* L.)，其中以小菜蛾爲主。按該蟲之發生非常普遍，且極不易防治。農民雖使用高濃度之 parathion 乳劑水釋液，亦無法達到防治效果，故此蟲已爲目前十字花科蔬菜之最主要害蟲。夜盜蟲亦爲普遍發生之害蟲，惟多種農藥對此蟲有良好之防治效果，故此蟲較易於防除，玆以此蟲與小菜蛾同時發生，又均爲害蔬菜之葉部，故本試驗乃將其一併研究之。

本試驗設於臺北縣蘆州鄉、樓厝村、農戶李元龍菜田中。本試驗爲11處理，一組對照，共計12組，各2重複計24小區。小區面積爲25.2平方公尺，總試驗田面積計604.8平方公尺。每小區植菜108株。所植蔬菜爲長岡2號包心白菜，係52年1月20日播種，自52年2月12日第一次施藥以後，每隔7天施藥一次，共施藥6次。稀釋液使用量，前三次爲每小區2.5公升，後三次爲3.0公升。

本試驗於52年4月20日採收，採收前先調查供試蔬菜之被害程度；調查時視蔬菜上之蟲孔數目，凡每株蔬菜上有20個以上蟲孔者即視爲被害株，求其被害株百分率列入第一表。此種被害情形雖已嚴重影響其經濟價值，但尚能予以廉價出售，故本試驗除調查其被害株百分率外，並稱其重量，蓋因此類蟲害能使植物發育不良，並誘發病害，因而影響其產量。稱量供試蔬菜之重量時先剝去蔬菜之外葉至一般出售之標準時，然後再行稱量其重量以公斤計算，求其平均單株重量，如第一表最末項所記。其採樣方法，係在供試田中之第3行及第6行各採樣40株。

二、結果與討論

本試驗各未施藥對照組之被害率均相當高，即示各組試驗區蔬菜之被害頗重，其試驗結果爲可靠。

本試驗所試三種蔬菜之主要害蟲，以0.1%濃度 malathion (50% malathion 乳劑1：500倍)之治蟲效果爲基準，較其效果爲佳者，依毒力之順序排列如下：

Ⅰ. 對韮菜薊馬有：0.025% zectran, 0.025% sumithion 及 0.05% DDVP*。

Ⅱ. 對荳綠椿象有：0.025% sumithion, 0.025% DDVP, 0.025% zectran及0.05% thiodan。

Ⅲ. 對包心白菜小蛾有：0.025% DDVP, 0.05% zectran, 0.025% diazinon△, 及 0.05% thiodan。惟 malathion 對小菜蛾之治蟲效果太差，不適宜用爲標準 (standard)，故本試驗設 0.05% diazinon 爲另一對照組，與其具同一效果者有 0.05% DDVP 及 0.05% zectran 。僅以治蟲效果討論，此類藥劑之藥效頗佳，有取用價值。

自包心白菜試驗組之產量看出，各用藥組之產量均較未施藥對照組爲高，即示施藥治蟲除能提高包心白菜之品質外亦能增加其產量。據本試驗結果：(1) 0.1% parathion 對小菜蛾之治蟲效果

註：* 同一藥劑，兩種濃度均達治蟲基準者，以低濃度爲代表。

△目前已在使用，本試驗列爲對照組。

表一、幾種主要蔬菜害蟲藥劑防治田間試驗結果

Table 1. Results of insecticide treatments against major vegetable insect pests.

項目 item	藥劑 insecticides	有效成分 active ingredient (%)	韮菜被害率 (%)，薊馬 % of leek leaves infested by thrips*				豇豆被害率，%椿象 % of asparagus beans. showing attacking by stink bugs*				包心白菜 Chinese cabbages: 被害率%，小菜蛾及夜盜蟲 %of plants showing feeding injury by diamondback moths* and army worms				包心白菜 Chinese cabbages: 產量 yield gm/顆 (heads)			
			I	II	平均 average	指數 index	I	II	平均 average	指數 index	I	II	平均 average	指數 index	I	II	平均 average	指數 index
處理組 treatment	DDVP 50% EC	0.050	6.2	3.8	5.0	6.3	4.1	2.6	3.4	13.0	0	0	0	0	663.5	794.5	731.5	281.3
		0.025	20.3	19.1	19.7	24.8	5.0	4.1	4.6	17.6	2.1	3.5	2.8	3.0	620.0	547.5	583.8	224.5
	sevin 85% WP	0.100	6.4	8.6	7.5	9.4	10.4	11.7	11.1	42.4	22.4	27.6	25.0	26.8	347.5	260.0	303.8	116.8
		0.050	22.6	18.5	20.6	25.9	15.8	12.2	14.0	53.5	33.3	20.0	26.6	28.5	272.5	275.0	273.8	105.3
	sumithion 50% EC	0.050	1.4	1.8	1.6	2.0	2.1	2.2	2.2	8.4	—	—	—	—	—	—	—	—
		0.025	3.0	4.0	3.5	4.4	7.1	6.2	6.7	25.6	—	—	—	—	—	—	—	—
	thiodan 35% EC	0.050	45.5	52.7	49.1	61.8	10.2	8.3	9.3	35.5	6.5	6.9	6.7	7.2	575.0	560.0	567.5	218.3
		0.025	48.7	73.2	60.9	76.6	8.7	12.3	10,5	40.7	23.4	23.4	23.4	25.1	507.5	477.5	492.5	189.4
	zectran 23% EC	0.050	1.9	1.0	1.5	1.9	2.1	1.7	1.9	7.3	0	0	0	0	730.0	700.0	715.0	275.0
		0.025	2.0	3.1	2.6	3.2	4.1	3.5	3.8	14.5	3.1	6.9	5.0	5.4	513.5	557.5	535.5	206.0
對照組 control	diazinon 20% EC	0.050	—	—	—	—	7.8	12.1	10.0	38.2	0	0	0	0	600.0	762.5	631.3	242.8
	malathion 50% EC	0.100	5.8	5.1	5.5	6.9	10.4	8.3	9.4	35.9	12.3	17.8	15.1	16.2	492.5	565.0	528.8	203.4
	parathion 47% EC	0.100	—	—	—	—	—	—	—	—	26.6	23.3	24.9	26.6	537.5	449.5	493.5	189.8
	未施藥 untreated	—	78.1	80.9	79.5	100.0	25.3	27.0	26.2	100.0	90.8	96.0	93.4	100.0	282.0	238.0	260.0	100.0

註：Note: (*) The scientific names of the insects are: thrip (*Thrips tabaci* Lindeman), green stink-bug (*Nezara viridula* L.) Diamondback moth (***Plutella maculipennis*** Curtis) and army worm (***Prodenia litura*** L.).

並不理想，若以其產量爲基準，在本試驗中較其產量爲高者有 0.025% DDVP, 0.025% zectran 及 0.05% thiodan。又 (2) 0.1% malathion 之治蟲效果較 0.1% parathion 略佳。若以其產量爲基準，較其產量爲高者計有 0.025% DDVP 及 0.025% zectran。(3)0.05% diazinon對小菜蛾之治蟲效果頗佳，若以其產量爲基準，較其產量爲高者有 0.05% DDVP 及 0.05% zectran兩種，此項以產量推算治蟲效力之結果與以治蟲效果所推算者相符合。

高毒性農藥(parathion)對小菜蛾之毒力並不理想。由此亦可證實，盲目使用高毒性農藥，除能造成可顧慮之遺毒問題之外，並不一定能够達到理想之治蟲效果。

綜合以上結果，就本試驗所試藥劑之治蟲效果看來，50%DDVP乳劑（本試驗所用者爲Nogos 50E），23% zectran 乳劑，50% sumithion 及 35% thiodan 均有取用價值，可以推薦。其中 DDVP 屬低毒性農藥，其毒性較低而分解較快，用以防治蔬菜害蟲，較爲理想。thiodan 爲遺毒治蟲作用較強之殺蟲藥劑，據另一試驗判定若以其 tolerance＝2 之標準，此劑在採收前 2週使用方爲安全。sumithion之消失較快，於採收14天以前使用即可絕對安全。故此類農藥在有條件之限定下，可以推薦使用。僅 zectran 一種其對動物之毒理作用尚不十分明瞭，tolerance 亦未確定，故其治蟲效果雖佳，但亦擬暫不予推薦。

三、有 關 文 獻

(1) Rateliffe, R. H., L. P. Ditman & J. T. Whitlaw, Field experiment on insecticidal control of insect pests of cabbage and broccoli, J. Econo. Ent. 54(2):356-359, 1961.

(2) Shorey, H. H., Field experiments on insecticidal control of Lepidopterous larvae on cabbage and cauliflower. J. Econo. Ent. 56(6):877-880, 1963.

FIELD TESTS ON INSECTICIDAL CONTROL OF MAJOR VEGETABLE INSECT PESTS

by

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English Summary

A project of vegetable insect pests control with comparatively safe insecticides had been conducted from 1962 to 1963. The chemicals used in the studies ware selected from a number of the newly developed insecticides, which had already been screened by the Pesticide Laboratory of Taiwan Agricultural Research Institute; they were 50% DDVP (Nogos 50 E, Ciba Ltd.), 85% sevin WP (Union Carbide Chem. Co.), 50% sumithion E C [O,O-dimethyl-O-(3-methyl-4-nitrophenyl) phosphorothioate, Sumitomo Chem. Co.], 35% thiodan E C (6, 7, 8, 9, 10, 10-hexachloro-1, 5, 5a, 6, 9, 9a hexahydro-6, 9-methano-2, 4, 3-benzodioxathiepine-3-oxide, Farbwerke Hoechst Ag.) and 23% zectran (4-dimethylamino-3, 5-xylyl methylcarbamate, Dow Chem. Co.)

Leeks, asparagus beans and Chinese cabbages were the crops tested. The insect pests on these crops were showed in Table I. The treatments on the testing crops

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were different as follows: (1) Four applications were made on leeks, with the dosage of 4.42 liters of water dilution per plot (36.9 M^2) for each treatment, it was equal to 12 liters per acre. (2) Five applications were made on asparagus beans. The dosage in each spray, for the first three applications was two liters and three liters for the last two applications. (3) Six applications were made on Chinese cabbages. The dosage of each treatment: 2.5 liters per plot for the first three applications and 3 liters for the last three applications. The results were obtained by examining the percentages of leaves attacked by the insects.

The yields were checked of the Chinese cabbage experiment. However, the yields of leeks and asparagus beans were not studied because it was a known fact that the percentage of injuried leaves of these two crops must be considered to be an economical loss.

The results are as followes:

During the time under the same water dilutions, the following concentrations of the chemicals are shown more effective than the 0.1% malathion, the standard.

1. To the thrips (*Thrips tabaci*) on leeks are: 0.025% zectran, 0.025% sumithion, and 0.05% DDVP.

2. To the green stink-bugs (*Nezara viridula*) on asparagus beans are: 0.025% sumithion, 0.025% DDVP, 0.025% zectran, and 0.05% thiodan.

3. To the diamond back moths (*Plutella maculipennis*) and army worms (*prodenia litura*) on Chinese cabbages are: 0.025% DDVP, 0.05% zectran, 0.025% diazinon 0.05% thiodan. However, the results indicate that malathion should not be used as the standard for controlling the two kinds of insects on Chinese cabbage. Therefore, 0.05% diazinon should, be used as the standard; under which 0.05% DDVP and 0.05% zectran have the same results as that of 0.05% diazinon.

Parathion 0.1%, gives a poor result in the control, of daimand back moths and of army worms on Chinese cabbages. The results, in Table I, indicate that the relative efficiences of the chemicals are: 0.05% DDVP>0.05% zectran>0.05% diazinon>0.025% DDVP>0.05% thiodan>0.025% zectran>0.1% malathion>0.1% parathion>0.025% thiodan>0.1% sevin>0.05% sevin.

文 獻 介 紹

ABSTRACTS OF LITERATURE

一、栽培稻及野生稻抗稻熱病之研究 1. 葉稻熱病對4病菌系之抵抗性[山崎義人，新關宏大 (1964) 育種學雜誌14 (1), 1～10]

由日本稻與美國稻雜交所育成的抗稻熱病品種，忽然消失抗病性，已認爲由於病菌有生理小種 (Physiological races) 存在之故。因此未來的新品種必須能抵抗不同生理小種始能保持眞正的抵抗性。本試驗利用來自東南亞各地之栽培品種 O. Sativa 357種，來自非州之 O. Glaberrima 50 品種，及包括12物種 (species) 之野生稻 38 品種爲材料，在秧苗時期用噴霧法接種 P-2, P-26, (P-2 之突變系統)，53-33 及 S-225 之四生理小種。接種 7-10 天後，按 a, b,c, d, e 及 f 之六級，調查病斑型以決定感病之程度，a, b, c 歸屬於抗病性，d, e, f 則歸屬於感病性。

檢定結果發現各品種對 3-4 生理小種之反應不同。O. Sativa 中之印度型稻與 O. Glaberrima 的大部分品種均對3生理小種表示高度的抵抗性。但大部分的日本種及來自臺灣、美國、菲律濱及埃及的品種對四個生理小種均爲感病。對野生稻而言，不同生理小種對不同物種之反應顯然不同，感病性之變異範圍亦大，表示抗病性對染色體組 (genome) 的構成及野生種無特別的相關存在。來自東南亞的 Aus 與 Bula 型稻有高度抗病性，與日本稻雜交時結實率亦高，故認爲導入抗病遺傳因子於日本稻種之良好材料。(謝順景)

二、利用放射線及化學誘變物質處理硬粒小麥 (durum wheat) 產生的突變 [G. T. Scarascia Mugnozza el. al. (1963). Consiglio Nazionale Delle Ricerche, Rome. Italy]

鑒於硬粒小麥在地中海區及義大利經濟上所佔的重要性，於1956年開始實施誘致此一作物的突變發生，以育成改良品系及行遺傳研究，誘變物質用 X-射線 (10×10^3r, 15×10^3X, 20×10^3r)；熱中子 ($8.38\times10^{12}/cm^2$, $10.5\times10^{12}/cm^2$, $12.5\times10^{12}/cm^2$, $14.7\times10^{12}/cm^2$)，快速中子 (200, 600, 800, 1000, 1200-rep) 及 EMS (Ethyl methane sulphonate 濃度 2.82%，3.76%，6,66%)，DS (Diethyl sulphate, 濃度 0.5%，1%，1.5%，2%)，材料爲 Cappelli 等五個品種。

在 M_2 代(既 X_1)發現多種葉綠素突變，包括黃色，白色，頂端黃基部白，頂端黃綠基部白色，頂端淡綠基部白色，白或黃的縱紋，棕或黃色橫紋，黃綠色及淡綠色等。此種葉綠素突變由化學物質誘致的相對頻度與由放射線誘致者有顯著不同。但在不同放射線間則不顯著。如 M_2 的突變率將 M_1 的存活率考慮在內，則由中子誘致的突變率數倍於 X-射線誘致者，此結果符合一向熟知的中子對生物上的作用較之 X-射線爲大，又普遍的特性爲高離子射線誘致的高突變率；使平均每穗 M_2 苗數 (旣平均每穗可稔率) 銳減，約 50%～80%，反之在 EMS 及 DS，最高突變率僅使每穗苗數減少33～42%。

由 M_2 及以後各代，共獲得 268 種突變，包括單一的或綜合的性狀，能影響植株的生理及外型而可以存活者；分析其中12種突變發現均爲單因子的遺傳 (隱性)。又分析突50突變體中，有25種爲染色體相互轉座者。

爲改良義大利的硬粒小麥品種，某些誘致的突變如短稈，勁稈 (solid Stem) 抗倒伏，穗數及小穗實稔實性的增加等，頗爲特出，爲評定其農藝上的性質，其中一部份分別於數處舉行產量試驗，結果六個品系較原來品種爲高。良好的生產力也出現在某些其他品系，伴隨

有好的品質，千粒重增加，短稈及強的抗倒伏性，另外有的突變系可抗 Meldren 及 septoria 病。在抗倒伏方面，Cappelli 品種在肥沃地易倒伏，而誘致的短稈突變品系則較能利用氮肥，此可能因具有較高的抗倒伏性之故。(何永安)

三、非洲棉業 [Horace G. Porter (1961) World Farming 4(7), 10~(9), 18]

本文分三期連載，將非洲各國棉業趨勢，棉作品種，及生產技術作概括叙述。首述非洲棉業趨勢，現正逐年開展。就1959年生產量而言，全非洲生產原棉計四百餘萬包。埃及獨佔50%以上，蘇丹佔16%，其餘乃各次要產棉國之和。非洲各國中，產棉者計31國。產棉甚少之國家凡10國，其國名如下：利比亞、獅子山、賴比瑞亞、迦納、加彭、布拉薩剛果、西南非、貝川納蘭、撒哈拉、索馬利蘭。非洲所栽培之棉種，三分之二爲 G. barbadense，即埃及棉。主產於埃及與蘇丹，有較長較細較強之纖維，而適合灌溉區之生產。埃及棉品種，在尼羅河三角洲區域者有4品種甚爲著名，即 Menoufi, Ashmouni, Karnak, Giza 30 等是也。新育成品種亦夥，多以 Giza 冠名，例如 Giza 51, Giza 58, Giza 66 等。西非洲之多哥，達荷美，奈及利爾等國所栽植之埃及棉品種爲 Mono 54 (譯者按 Mono 爲多哥之河流名稱)。

至於陸地棉種，即 G. hirsutum，佔全洲其餘三分之一。具短粗而較白之纖維，其品種在各國不同。最著名者爲羅得西亞之 Albar 637，亦產於東非與中非，有極強之抗病力。剛果國之 C_2 亦具有抗病蟲害力，正在替換原來之品種 Gar 之過程中。奈及利爾之陸地棉品種爲 Samaru 26 J，其品質與農藝性狀均佳。此外非洲之陸地棉品種，多係 Allen, Stoneville, Acala 4-42，數品種之血緣。

非洲植棉歷史雖久，而農民極端重視糧食作物；故多數國家之植棉狀態尚爲原始狀態。惟埃及與蘇丹植棉技術，業已完全現代化。作者認爲改進非洲植棉技術，有採用下列數點之必要：(1)儘可能早播，(2)施用肥料足量，(3)清除棉田殘莖，(4)不間作，(5)每穴二株之習慣，應以間苗矯正之，(6)早收穫，(7)防治病蟲害，清潔棉田。(孫貽謀)

四、枝梗稻熱病發病機構及其生態之研究 [平野喜代人，後藤和夫 (1963) 日本農業技術研究所報告 C(16), 1~58]

本報告由人工接種及圃場觀察，探討枝梗稻熱病之發病經過，又自植物病理解剖的觀察稻熱病菌侵入穀粒之經緯。據接種後之發病樣相，可分爲穀稻熱病(包括護穎稻熱病，I型)二次枝梗稻熱病 (II型)，一次枝梗稻熱病(III型)，穗軸稻熱病 (IV型) 等四型，但二次枝梗稻熱病可細分由自穀起原二次枝梗稻熱病 (II-a 型) 及自枝梗節起原二次稻熱病 (II-b 型)。

各部位之感染與枝梗罹病度 (穗的部份枯死量) 之關係每一感染部位則穗軸節感染>枝梗節感染>穀感染，即較近穗頸節或穗軸部位被感染時被害爲大，但自枝梗稻熱病之被害全體觀之，其被害程度爲穀感染>穗軸節感染<枝梗節感染之順位。解剖發病穀粒者病斑部位之組織呈壞死或崩壞，菌絲之蔓延在內面表皮較多，外面表皮中位，下皮組織稍少。其分生胞子形成於病患部之穎外面及穎花腔內面。侵入穎內之菌絲在接種後24小時達到下皮組織，48小時達到柔組織及內面表皮，72小時後蔓延到各組織內。稻抽穗後行人工風每秒9公尺及12公尺處理2.5或3小時者，穀粒及枝梗等之傷痍極嚴重。即該傷痍在後期呈楕圓形斑或不正圓形斑，或穀全粒呈黑褐色化之症狀。又人工風處理直後之枝梗易受病菌之侵入，其發病程度爲受傷嚴重之材料愈易受害，則由傷痍部位病菌易侵入之故。在抽穗齊期行接種者，枝梗稻熱病之罹病度較輕微，但其穗重會減輕，不稔粒也很顯著的增加又在抽穗後之後期行接種者，枝梗罹病度雖較高，但穗重之減輕或不稔粒之增加程度均爲不顯著，但精糙米之千粒重有愈後期接種愈輕之傾向，因此可知抽穗後之晚期感染，對產量也有影響。(簡錦忠)

五、植物毒素病化學療法之研究 VI. 各種抗毒素性藥劑之撒佈實驗 [平井

篤造] (1962) 日本植物病理學會會報 27(3), 115～121]

主要用藥劑之莖葉撒佈（據 Bancroft and Curtis 之變法，測定莖葉內之 virus 核酸量），一部份用土壤灌注法，檢討對植物毒素病之全身感染及局部感染之抗毒素劑之效果，結果對接種 TMV (Tobacco mosaic virus) 之菸草，混合接種 TMV+PVX (Potato virus X) 之蕃茄等，Actidione（含有 Naramycin),Thiouracil, Dextromycin 等之莖葉撒佈，有稍可延長其潛伏期間，並減少其體內之 virus 量之作用。對接種 CMV (Cucumber mosaic virus) 之蕃茄，除上述作用之外並稍可減低其發病率。由 TMV 之接種在菜豆・*Nicotiana glutinosa* 上所形成局部病斑，及由 PVX 之接種在辣椒上所形成之局部病斑，應用 Actidione, Thiouracil之葉部撒佈，或塗布，均可顯著阻止其形成。對黑尾浮塵子所誘發之稻萎縮病，Actidione・Thiouracil・Py-41 (2, 4, 6-triamino-5-phenylazopyrimidine) 等有稍可延長其潛伏期間之趨向。Thiouracil 之土壤灌注可減輕 TMV+PVX 之混合接種而起之蕃茄 Necrosis 性病害。

以上，對於植物毒素病，化學藥劑之效果雖尚未至完全之程度，惟著者認為阻止病斑之形成等特殊用途，誠可應用。此暗示採用稍具抵抗性之品種時，併用藥劑撒佈具有意義。對病原性弱之 virus 或病原性甚強之 virus 應用土壤灌注，或其餘較特殊之藥劑施用法，均可期待其效果。因莖葉之撒佈時，旣有可延長其潛伏期間或減輕體內 virus 量之藥劑存在，故使用於稀薄感染之毒素病等，依適當方法稍有可使用之可能性。（吳福壽）

六、臺灣經濟植物 *Diplodia* 病害之研究－落花生莖腐病 [T. C. Lo(1963) Plant Protection Bulletin 5(3) 362～385]

落花生莖腐病係花生之一種新病害，為 *Diplodia arachidis* Petcb. 引起者。病原菌於花生種子播種後以至於收穫期均能為害。自1956年5月於臺灣發現該病以來，花生之罹病率有高達70%者。

病徵之出現主要是在莖的基端以及根部，有時亦可為害及葉柄。幼苗受害時，子葉首先變黑，其後枯死。受害莖部首先是呈現水浸狀病斑，其後下陷，因為輸導組織受害，故幼葉萎凋，老葉下垂，其複葉則捲曲。在受害部位有許多黑色之小點產生，此即是病原菌之柄子器。根部受害時組織呈黑色，有崩潰現象發生，植株因而死亡。

罹病組織上之柄子器為單生，球形或卵圓形，大小在162.5×150～237.5μ 之間，平均大小為 223.7×192.5μ。柄胞子具一隔膜，不透明，深棕色，橢圓形或卵圓形，大小在 21.6～35×11.5～15μ 之間，平均大小為 24.9×13.2μ。病原菌之發育溫度為 4～32～40°C，胞子發芽溫度為 16～30～40°C，pH 值在2.5～6.5～10.0 之間。不同培養基之生長比較中以馬鈴薯培養基較佳，合成培養基中以 Czapek's 培養基獲最佳之效果。柄胞子之產生以玉米粒最佳。子座之產生以增加蔗糖之培養基上有優良之效果。接種方法無論使用傷痍或非傷痍接種，均可達致發病之效果，然後者之潛伏期較前者為長。植物株齡愈大，其抗病力之傾向也愈大。同時由土壤接種試驗證明，本病可經由土壤傳播。

病原菌對於藥劑之反應，室內試驗結果，以Semesan及Granosan(濃度各為100 p p m)，浸漬5分鐘之效果最優，其次為 Granosan GN, 而土壤灌藥試驗則以 Vapam-4S 最佳，Uspulun 次之。（徐惠廸）

七、柑桔潰瘍病之研究 I [M. Goto (1963) 靜岡大學農學部研究報告第12號 1～72]

作者於本報告中，以日本中部——靜岡地區為環境，以1915年起共六十多種前人之研究作參考，對柑桔潰瘍病病原菌之系統分化・病害生態等諸問題進行研討。試驗工作仍在進行，本報告為第一報。作者以三百多菌株供作生理特性試驗結果，發現其大部份特性均與 Hasse, Petier 等氏於早年報告者相同，惟以其對 Mannitol, Mannose, 及 Lactose 等分解能力之不同而區分為 A_1, A_2, B_1, B_2, 及 C

等五種 Biochemical type 。各 type 分離自不同地區與不同柑桔品種之頻度並不一致，但各 type 供作傷痍接種所呈現對溫州蜜柑等之病原性並無二致。五種 Biochemical type 復以其對六種供試 *X. citri* 之 Bacteriophage 反應之不同而區分爲12個 Lysotype。作者認爲 Biochemical type 之區分，於潰瘍病傳染原之探尋上，頗具重要性。

有關病害生態之硏究，作者於文中闡述頗爲詳盡。據作者調查，越冬病斑內病原菌之生存率爲40～80%，一般言之，夏秋梢內病原菌越冬率較高，而成爲翌年第一次傳染原之一。越冬病斑內病原菌之增殖始於平均氣溫10°C，或最低氣溫 5°C 之時，即於三月下旬至四月上旬開始。在夏橙之越冬夏秋梢上曾發現潛伏性病斑，此種病斑亦可由人工接種而呈現，潛伏性病斑亦爲翌年第一次傳染原之一。罹病性柑桔品種之枝條，葉片及果實之罹病性均隨其成長度而遞減。枝條於開始抽出時，以其生長基部最爲感病，其後隨其生長而感病度逐漸上延，一般由抽出之三、四星期後即具抗病性；葉片之罹病性以中度展開至剛好展開完畢者最高；果實之罹病，幼果以氣孔感染爲主，隨着果實長大則漸以傷痍感染較爲重要。一般病斑於接觸水滴後15分鐘或最遲於72小時即能析出病原菌。氣孔感染所須病原菌懸浮液濃度爲10^5cells/ml，而傷痍感染則僅須。10^2～10^3cells/ml。傷痍與接種之間時間之長短對病害發生有着重要之關係，如傷痍後 10 hrs 始接種則感染度僅爲16～18%；而經 72 hrs者，即不再被感染。（楊騰金）

八、菌株之凍結乾燥保存法［土屋行夫（1963）植物防疫 18(9)，301～312］

各種生物學所用之材料，在乾燥狀態下較自然狀態容易長期保存之事實，自古爲人所週知。在1909年 Shackell 氏爲期更長久保存微生物，防止變質，阻止雜菌侵入等目的而創設凍結乾燥法，事後經各界之改良應用，尤其在醫學、生物化學、藥劑學、組織培養學等方面，已有相當之成就。在植物病理學方面之應用，尙在初步試驗之階段。

本文主要介紹在農業技術硏究所試驗植物病原微生物之長期保存所得之初步結果，利用(1)放置被乾燥物之蒸發器，(2)帶有冷凍設備之去濕器，及(3)眞空抽氣機之三大部份構成之中、小型凍結乾燥器（圖 2 種）根據減壓蒸發之原理舉行試驗。放在玻管中待乾燥物之水分，因高度眞空而昇華，蒸氣通過冷凍器而被吸濕，待充分乾燥後將玻管口以噴燈燒封將此材料保存於低溫中。

按上述之方法在 1962～1963 年試保存 *Agrobacterium, Corynebacterium, Erwinia, Pseudomonas*，等各屬之細菌各生存 4 年10個月至 8 年11個月，同時判明其病原性之存在。另一方面試驗水稻胡麻葉枯病菌，小麥條斑病菌，甘藷黑斑病菌時，已判明各菌均能生存 5 年10個月至 7 年 2 個月以上。但對稻熱病菌及刺瓜炭疽病菌之培養却因凍結乾燥後立刻死亡而未獲成功。

在糸狀菌之凍結乾燥方面有多數菌於施行凍結乾燥後立刻死亡，甚難利用此法。植物病原菌類，此方面之正式資料尙在初試時期，尙待開拓之部份尙多；這些保存困難之植物病原菌類，今後需從凍結乾燥作用之基本硏究，分散媒之化學構造解析，及微生物本身生理條件之檢討等三方面進行綜合性之基本硏究。我們堅信不久之將來，保存困難之眞菌類仍能利用凍結乾燥法來保存。（杜自疆）

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CONTENTS

Influence of Planting Methods on the Variability and Correlations of Agronomic Characters in the F_2 Populations of a Japonica Rice Cross ......W. L. CHANG...... 1

Studies on the Cultivation of Ratooned Rice
Varietal Variation on Ratooning Ability and Yield......C. F. HSIEH, S. KAO & C. CHIANG......14

An Introduction of the Experimental Results of the Sweet Potato Variety "Okinawa No. 100"......C. K. CHIEN......22

Flow Equation and Its Application to Water Movement in Soils ......L. T. LI......31

Effect of Chemical Elements on the Growth of Crop Pathogens
II. Effect of Hg-, Ni-, Sn-, Pb-, Fe- and Al- Salts on Rice Blast and Sheath Spot Fungi......S. C. HSU, T. C. DOUGH......38

Studies on the Drug Resistance of *Piricularia oryzae* Against Mercuric Chloride......C. C. CHIEN......44

Utilizations of the Special Canker Lesion on Sunki Leaves......T. C. YANG......51

Some Physiological Studies on *Fusarium oxysporum* F. *Niverum* (E. F. S.)
S. et H., The Causal Agent of *Fusarium* Wilt of Watermelon......K. Z. HU, S. F. SON & C. C. YU......57

Field Tests on Insecticidal Control of Major Vegetable Insect Pests......T. CHIEN, T. T. LIANG & S. C. LIN......65

ABSTRACTS OF LITERATURE......69

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